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The New York Rapid Transit Commission has at last reported progress in the form of an answer to the application for extension privileges of the Manhattan Railway Co. sent in on Jan. 19. The report of the commission of March 11 disapproves of the extensions asked for through Greenwich, Canal, Centre, 42d and 53d Sts., and 149th St., Lenox Ave. and 128th St. to Third Ave. It approves of extensions through 129th and 177th Sts., and also approves the application for additional tracks on the Bowery and Third Ave.; on the Second Ave. line from Chatham Square, and on the Ninth Ave. lines. The company may also use independent motors, to be operated by steam, electricity or compressed air. The commission's resolution also requires a third line along Park Row from Chatham Square to Tryon Row; two tracks through Catharine or Oliver St., or through private property between these streets, diverging from the present structure at Division St. and Park Row to South St. The Manhattan Co. must also provide additional facilities at the City Hall terminus, and construct a two-track line through Greenwich and Eighth Aves. and 14th St., from Sixth to the Ninth Ave. lines. All new structures must be strong enough to permit the running of trains at 35 miles per hour; not more than 5-cent fares can be charged, and all these improvements are to be completed in two years from date of consent of city authorities and property owners.

The tunnel now being constructed under the East River, by the East River Gas Co., is 8×10 ft., and is to be about one-half mile long when completed. The headings are now out about 500 ft. from the New York side, toward Blackwell's Island, and 100 ft. out from the shaft on the Long Island side. Compressed air is being used to hold back the water, and as the New York end is 134 ft. and the Long Island end 147 ft. below mean low tide, the pressure is correspondingly severe. It is, in fact, the greatest depth at which air-pressure has been used in work of this description, to the best of our knowledge. The men work in 4-hour shifts; but one foreman is said to have already died from the effect of the great air-pressure, and three of the workmen were taken out unconscious on March 10, and are in the hospital in a dangerous condition. The tunnel is being built to carry one 48-in. and two 30-in. gas mains from the Long Island City works to New York, landing at the foot of 71st St. The material being tunneled is a hard gneiss rock, and the use of compressed air was not contemplated originally, as the borings indicated a very compact material.

Electric power plant is wanted by the Moodie Gold Mining & Exploration Co., of London, to be erected on its property near Barberton, South Africa, for generating and transmitting 250 HP. by electricity to various sub-companies. Specifications can be seen at the office of Corner Bros. & Co., New York, but as the advertisement says that "three guineas will be charged for copies of specifications, conditions of contract, etc., and inspection of plans, which will be returned on receipt of a bona fide tender," it is not likely there will be much American competition for the contract. American contractors do not do business in this absurd way, which is being more and more unfavorably regarded in England.

An example of the "things one would rather have expressed differently" is found in the following extract from an interview of a "Tribune" reporter with Mr. Samuel Sloan, one of the Directors of the Manhattan Elevated Ry. The subject of the interview was the extensions and alterations of the elevated system proposed by the New York Rapid Transit Commission:

Reporter: "Do you think the present elevated structure strong enough to support the further weight of three tracks and more rapid trains?"

Mr. Sloan: "Certainly; you have no idea of the anxiety with which our engineer watches the present structure. It is carefully examined continually."

The most serious railway accident of the week was a head collision March 9, at Union City, Ind., on the Bradford & Logansport Division of the Pittsburg, Cincinnati, Chicago & St. Louis Ry. A westbound passenger train had orders to sidetrack for an eastbound fast freight train, but the engineman, in disregard of orders, tried to make the next passing place, with the usual result of causing a collision. Both engines, a mail car and several meat cars were wrecked, and eleven persons were injured—none fatally, however.

A locomotive boiler explosition occurred March 13, at St. Elmo, N. Y., on the Philadelphia, Reading & New England R. R. The engine was hauling a freight train, and was making its first trip after having been in the shops for repairs. It is reported that the crown sheet collapsed owing to low water in the boiler.

A movable earth and rock excavator, 300 ft. long, having a cantilever arm projecting over the waste bank 120 ft., is being designed by Mr. Henry Goldmark, M. Am. Soc. C. E., of Chicago, for use on the drainage canal of the Sanitary District. It consists of a Howe truss span, supported by two towers, 40 ft. high, placed on each side of the cut. Two cars of 5 yds. capacity each will be raised and transported at a time. Its estimated capacity is 700 cu. yds. per hour.

The Coal Brick Co. has been organized in England to control the patents of T. W. Lee, for the manufacture of coal bricks from any description of coal or coke dust or slack, by which it is claimed that bituminous and anthracite coal dust or coke dust can be made into bricks with equal facility and at less cost than with pitch or other volatile matter. The material has been tried in England, and proved to evaporate as much water per pound as natural coal. The cost of making the bricks under this system is said to be less than by the use of pitch, and the bricks have been very favorably reported upon. Coal bricks made with pitch as the cementing medium are extensively used in European locomotives, particularly in Belgium and Italy.

The number of Brooklyn Bridge Trustees is to be reduced from 20 to 8 by a bill now before the New York Legislature, and which has passed the Senate. The chief reason given for the change is that the present board is too unwieldy, and a quorum for the transaction of important business is often secured with difficulty. The bill provides for a president's salary of $5,000 per annum; $4,000 to the secretary and treasurer, and $3,000 per year to the members of the board.

The electric light has been adopted by the London General Omnibus Co. to replace the dim oil lamps formerly used. About 140 omnibuses are already equipped with the accumulators and incandescent lamps, and this number will be increased. The battery weighs only about 8 lbs., and is placed in a box under one of the seats. The box is provided with two brass terminals, which make contact with the battery when it is let down into the box. The lamp is of special manufacture, and is made as small as possible, so that it may be placed against the roof or at either end of the omnibus without inconvenience to the passengers, and for the same reason the lamp is placed horizontally. The capacity of the accumulators is such that a single charge is sufficient for one day's service.

The Chicago Power Supply & Smoke Abating Co. has secured a decision from the courts of that city permitting it to go on with its contemplated work of laying a conduit through the business portion of Chicago for the supply of compressed air, at 100 lbs. per sq. in. Mr. John P. Bacon is the manager of the company, and he proposes to tunnel by forcing forward a steel shield nearly 7 ft. in diameter by compressed air. In the opening thus made a 6 ft. pipe, in four sections horizontally, will be bolted together. Branches for future connections will be provided at cross streets, and Mr. Bacon expects to progress with the main tunnel at the rate of 30 ft. per day. The tunnel bottom will be about on a level with the foundations of the heavier buildings. The purpose of the company is to provide compressed air for power purposes and for ventilating theatres, schools and hospitals. A pneumatic tube system, for mail and packages, is also contemplated. Just now the work is at a practical standstill, owing to some misunderstanding between the city and the company as to the right to use a part of the Lake Front Park as storage for material to be used in construction. The city's permit allows the use of streets only during the progress of the work.

The variation in cost of pumping engines with variation in duty is a subject on which few figures are available. This makes the following list of bids recently received by the Olympic Salt Water Co., of San Francisco, of especial interest. The specifications prepared by the company's Consulting Engineer, Mr. D. E. Melliss, says "The Pacific Lumberman," called for one main engine with a daily capacity of 2,500,000 gallons against a head of 340 ft., and an auxiliary pump of 250,000 gallons daily capacity. The bids were as follows:

Dow Steam Pump Works.	Duty.	100,000,000	75,000,000	60,000,000
	Price.	$18,600	$16,850	$15,500
Henry R. Worthington.	Duty.	100,000,000	75,000,000	55,000,000
	Price.	$20,905	$14,625	$9,950
Risdon Iron & Loco. Works.	Duty.	105,000,000	80,000,000	
	Price.	$23,600	$18,500	
Frazer & Chalmers.	Duty.	90,000,900		
	Price.	$28,000		
Fulton Eng. & Ship B'd'g. Co.	Duty.	100,000,000	130,000,000	62,500,000
	Price.	$28,000	$35,000	$12,500

The contract was awarded to the Dow Steam Pump Works. The plant installed will consist of two Corliss condensing engines, driving double acting plungers, and an auxiliary compound condensing Dow duplex steam pump. Air chambers will be fitted to both suction and force mains. The contract price includes all the engine-room fittings and an independent surface condenser and air pump. Comparative prices of larger pumping engines with varying duties were given in our issue of Dec. 22, 1892.

The Transandine Railway works have recently been inspected by Mr. Baggallay, an English engineer, with a view to the completion of the section of the line which lies in Chilean territory. The concession is held by the firm of J. & M. Clark, who are not in a position to continue the work at present. Mr. Baggallay, representing Sir Douglas Fox, was commissioned to ascertain whether economy can be effected by a decrease in the tunneling operations which form a very heavy item of the expenditure no remaining to be incurred. If the cost can be sufficiently brought down, a syndicate is willing to complete the works on the Chilean side in order that through communication by rail between Argentine Republic and Chile may be secured at an earlier date than would be the case under present conditions. The railway was described in our issue of Feb. 13, 1892.

The production of precious metals in the United States for 1892 has been reported upon by Mr. E. O. Leach, Director of the Mint. The value of the gold product was approximately $33,000,000; silver, 58,000,000 ozs., valued at $50,750,000 as silver, and $74,989,000 at the coining value of silver dollars. The U. S. Government purchased in the year 54,129,725 fine ounces, at $47,394,291, an average of 87½ cts. per ounce. The gold imports aggregated $18,163,056, and the exports $76,736,592, for the year. The silver imports aggregated $31,450,968, and the exports $37,541,301. The total metallic stock on hand for Jan. 1, 1893, was estimated to be: Gold, $649,788,020; silver, $593,365,365; total, $1,243,153,385. The total amount of money in circulation (exclusive of the amount in the Treasury) was $1,011,321,753 on Jan. 1, 1893; an increase of $18,929,124 in the year.

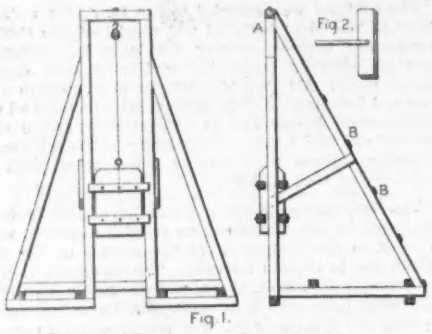
Worcester, Mass., is proposing to build a boulevard 100 ft. wide, as an extension of Hamilton St., and terminating at Lake Park, on the shores of Lake Quinsigamond. This avenue would be about 6,000 ft. long. The only special feature is the separation of the grade for about 1,700 ft. in length. At this place the road skirts a side hill with a slope of 15 ft. in 100 ft., the width of the avenue. The avenue is here divided longitudinally into two ways, each 50 ft. wide, by a terrace in the middle, the surface of the upper way laying 5 ft. above that of the lower way. The central terrace, like the other two, is sloped and sodded, and is to be planted with trees. This is the plan of City Engineer F. A. McClure; and while it will add to the picturesque effect of the avenue, it will also save much expense in road construction at this point. The terrace plan also more easily permits the future grading of lateral streets into both the upper and lower roadways.

AN ECONOMICAL SHEET PILE DRIVER.

By Julian A. Hall, M. Am. Soc. C. E.

The accompanying sketch of an economical sheet pile driver is so simple that it explains itself at a glance. The machine was designed especially for coffer-dam work, but it can, of course, be used to put in sheet piling wherever such work is necessary. The method of operation is very simple. After the piles have been driven as deep as possible with a maul, the machine is used to drive them as deep as may be necessary. It is particularly adapted for use in rocky and sandy river bottoms, as it will quickly and cheaply jam the piles upon and between small boulders, and thus close openings that might otherwise cause a great deal of expense, trouble and delay.

The hammer is made of a section of an oak or other hardwood tree, squared or flattened, and of such size as may be necessary. Stout pieces of wood are bolted to the sides of the hammer, to hold it in the ways. Sufficient play should exist between the hammer and the ways to keep the hammer from jamming, and a like allowance should be made, for the same reason, between the ways and the pieces that hold the hammer between them. The machine should be built of sawed lumber, and inferior stuff will answer for the purpose as well as the best heart. The verticals may be made of 4-in. × 2-in. pieces, but for the other pieces lumber of a much less size will do perfectly well. The machine rests on 6-in. × 6-in. square stuff or anything handy about the work, and it is sufficiently light to be easily moved by two or three men with bars. To prevent toppling over in moving, it should be anchored bottom and top, fore and aft, with snub lines, which are payed



Sketch of Economical Sheet Pile Driver.

out or hauled in, as may be necessary. From A, Fig. 1, the rope through the block passes over B, B, B, which are like rungs on a ladder, and on which men stand and pull the hammer up and let it fall. From three to six men are necessary, according to the size of the machine, and one of them keeps time in a sing-song tune, thus insuring unanimity of action. In a short time the men get the hang of the motion and lift the hammer with a small expenditure of force. Fig. 2 shows a piece of lumber, the size of a section of the piles to be driven, with a handle fitted into it. This is used to cause perfect penetration of such piles as go deeper than those adjacent. This is usually held by the gang boss, who watches the penetration and gives the word when to stop driving.

The principal points of advantage in the use of this machine are the cheapness, effectiveness and rapidity with which work can be done. It can be put up quickly and at very little expense, and when no longer needed the material can be otherwise used or abondoned, only the bolts, etc., being saved for the next job.

DIFFUSION OF LIGHT THROUGH RIBBED GLASS.

Among the many other subjects of technical importance which have been investigated by the Boston Manufacturers' Mutual Fire Insurance Co. is that of the diffusion of light, in its practical application to the lighting of factories, etc., on which a recent circular from that company sheds new and interesting light. The tests showed that a plate of clear, double-thick German plate glass, ⅛ in. in thickness, such as is customarily used in glazing factory windows, obstructs light from an Argand gas burner about 8%. Light passes through such clear glass without diffusion, making an image corresponding to the somewhat crude impression given in Fig. 1, when the light is put through an aperture of about the same size as the image. A direct transfer from the photograph could not be made, and the original impression was engraved on wood. The light is, of course, intense where it strikes, making deep shadows, but it is not diffused.

The same light, passed under similar conditions through a plate of fine ribbed glass ⅛ in. thick, is diffused 69° to 70°, and there is no greater obstruction or loss in transmission than through the clear glass, an important feature which is not generally understood. This diffused light is not intense at any point, and heavy shadows are therefore avoided. The image given by the photograph has been copied as well as it might be in the cut Fig. 2. The glass is known as "factory glass,"

FIG. 1. DIFFUSION OF LIGHT THROUGH CLEAR GLASS.

and is a very pure white crystal. It is stated that on the south side of a building even this kind of ribbed glass may be too clear, and although the light may be diffused very adequately through the room, it may be yet a little too bright near the window. The glass is sold by Hills, Turner & Co., 193 State St., Boston.

There are several varieties of fine ribbed glass of a greenish tinge. The more green it is, the more the intensity or glare of the light will be overcome, while the diffusion will be equally well assured. It

FIG. 2. DIFFUSION OF LIGHT THROUGH RIBBED GLASS.

may, therefore, be expedient, under some circumstances, to try both kinds before deciding which to use, so as to be certain to avoid the need of window shades. The greenish glass will obstruct the light a little more than the pure crystal glass, and may be used without window shades. It may, therefore give a more effective illumination than clear, plain glass or the crystal ribbed glass when either is screened with window shades. On any exposure but the southern, the crystal ribbed glass may probably be used without window shades. In glazing with ribbed glass, the smooth side should be outward, the ribs inward.

In calling attention to the advantages of ribbed glass for railway stations and shops, factories, etc., it may also be noted that it may well be applied to all kinds of windows having an unpleasant outlook. It is already being used to some extent for stations on the New York Central R. R.

STAND-PIPES AND THEIR DESIGN.*

By Freeman C. Coffin, C. E.

(With inset.)

There has been very little written upon the subject of stand-pipes, in consideration of their importance in water-works construction and their great and growing use. The literature of the subject is extremely scanty. I do not know of any book upon it, nor have I been able to find any treatment of it in any general work on water-works construction. There are a few good papers and some writing of a fragmentary nature.

Mr. John F. Ward has an article in the Engineering News of July 24, 1886, which contains many practical ideas in relation to construction.

Mr. A. H. Howland read a paper before the Engineers' Club of Philadelphia in 1887, in which he made some valuable suggestions, and gave a table of minimum thickness of top plates and other dimensions.

Mr. B. F. Stephens read a paper before the American Water-Works Association, which is published nearly in full in the Engineering News of Oct. 6, 1888. This paper contains a discussion of several failures, and also a valuable statistical table of many stand-pipes

* Read before the New England Water-Works Association on Feb. 8, 1893, and slightly condensed for these columns.

in use. The table was published in the Engineering News of Oct. 13, 1888.

The "Engineering Record," in the issue of April 25 and May 2, 1891, published, in full, a paper read by Mr. W. Kiersted, before the Rensselaer Society of Civil Engineers some time before. In this paper is a theoretical discussion of the strains upon a stand-pipe, with several formulas, and a useful table of rivets and spacing. I shall refer to these papers in my discussion of the subject.

The first question in the design of a stand-pipe is the size. The element of height comes first, and this is largely determined by natural conditions. It is not within the province of this paper to discuss the head required to provide suitable fire streams, for that question is decided quite independently of the stand-pipe; and when that is fixed in any particular case the topography of the locality will determine the height of the stand-pipe. In a hilly country it must be a compromise between a heavy pressure in the low portions and a light pressure on the hills. In this section an elevation can usually be found where it need not be of excessive height in order to give a satisfactory pressure over the greater part of the territory to be served; but different conditions prevail on the level lands of the West, and the influence of these is seen in the types of stand-pipes built in the different sections. In the Eastern states the present tendency is toward a stand-pipe, or more correctly a tank, of large diameter, whereas on flatter country they are nearer what the name implies—a stand-pipe or water-tower, with great height and small diameter, the result of the necessity of obtaining sufficient head, combined with the desire for small expenditure.

I believe that the height, as it is the first element to be determined, has also been generally considered the most important, and the holding capacity has nearly always been rated as the area of cross-section multiplied by the entire length or height, with the result of building a tall pipe of small diameter, and vice versa. A desire for saving in first cost also tends in the same direction.

But when the subject is examined rationally, it will be seen, I think, that the question of diameter is almost entirely independent of that of height. The efficient capacity must be measured by the length from the high water line to a point below which it is undesirable to draw the water on account of loss of pressure for fire supply, whether that point is the actual bottom of the stand-pipe or above it. This allowable fluctuation, I should say, ought not to exceed 50 ft., in most cases, in a well designed system. This makes the diameter dependent upon two conditions, the first of which is the amount of the consumption during the ordinary interval between the stopping and starting of the pumps. This should never draw the water below a point that will give a good fire stream and leave a margin for still further draft for fires. The second condition is the maximum number of fire streams and their size which it is considered necessary to provide for, and the maximum length of time which they are liable to have to run before the pumps can be relied upon to re-enforce them.

The diagram, Fig. 2 (on the inset) gives the number of feet which water in tanks of different diameters will be lowered by different populations using 60 gallons per head per day with the pumps running 8 and 10 hours in the daytime and being stopped at night.

This raises the question of the relative draft at different times of the day. Figures showing the ratio of maximum and minimum draft to the average draft per minute for the entire day would be of great value. The last is easily found from pumping records, but the writer, recently having need to know approximately the maximum draft could find no figures relating to it. Through the kindness of Mr. Byron I. Cook, Superintendent of the Woonsocket (R. I.) Water-Works, where there is a recording pressure gage on the stand-pipe, I obtained the cards for one month, and computed the maximum hourly flow for each day. This case, as you may see on the diagram, Fig. 4, was plotted from one day's record, and gives the hourly maximum 86% greater than the daily average. The average draft per minute from 6 p. m. to 7 a. m. was but 46% of the average daily draft per minute, and this was used as the basis of calculation for the diagram. This was but one day in one city, but it will be seen that the daily average was close to the monthly average, by referring to the diagram.

The diagram, Fig. 3, shows to what depth any number of fire streams of 200 or 250 gallons per minute will draw the water in tanks of different diameters in one hour, which should be the maximum time before the pumps can reinforce the tanks.

Another reason for making the diameter large is to provide for stability against wind pressure when empty. The writer has seen a tank 30 ft. in diameter and 113 ft. high lifted ¾ in. from the foundation on one side by a strong wind, but not one of the strongest winds we have in this section.

The following table gives the height of stand-pipes beyond which they are not safe against wind pressures of 40 and 50 lbs. per sq. ft. The area of surface taken is the height multiplied by one-half the diameter:

Heights of Stand-Pipe that Will Resist Wind Pressure by Its Weight Alone, when Empty.

	Wind, 40 lbs. per sq. ft.	Wind, 50 lbs. per sq. ft.
20	45	35
25	70	55
30	150	80
35	...	160

To have the above degree of stability the stand-pipes must be designed with the outside angle iron at the bottom connection, as shown in Fig. 1, A (on the inset sheet).

I consider any form of anchorage that depends upon connections with the side plates near the bottom unsafe. If attached at points on the side plates, as all forms of brackets and holding down bolts are, a strain comes upon the plate that it is not usually designed to bear in addition to the strain caused by the water pressure, although it may be said that both strains will not come together. But aside from that, the strain which the wind pressure brings upon the horizontal joints is not lessened by this method, which holds the bottom to the foundation, and leaves the rest of the pipe to resist the wind as a cantilever, whereas by suitable guys the wind pressure is resisted by tension in the guys, and the stand-pipe is relieved from wind strains that tend to overthrow it. The guys should be attached to a band of angle or other shaped iron that completely encircles the tank, and rests upon some sort of bracket or projection, and not be riveted to the tank. They should be anchored at a distance from the base equal to the height of the point at which they are attached, if possible.

The best plan is to build the stand-pipe of such diameter that it will resist the wind by its own stability. The foregoing suggests that a tank might be elevated upon a foundation or base, as the top 50 ft. is all that will give the proper efficiency as storage capacity, and, in fact, this has been done in some cases and this part of the subject will be touched upon in the latter part of this paper.

The height and diameter having been decided, the material of which to build is the next point to be considered. Stand-pipes are built successfully both of iron and steel, and I suppose the final word cannot yet be said in regard to the comparative merits of the two, everything being considered, but it may be a suggestive fact that all or nearly all failures have been of steel, unless I am misinformed. This may be due only to poor design or construction, which it certainly was in some cases. This brings up the subject of failures and their causes, and I will mention a few of the noteworthy ones in the United States within the past ten years:

Defiance, O.—This was one of the later failures. It occurred March 29, 1891, and was fully described in the "Engineering Record" of April 11, 1891. This pipe was 22 ft. in diameter and 140 ft. high, built of steel, with the lower ring ⅝ in. thick. Strength of materials not stated, but for a factor of three at the joints it should have been 65,000 lbs. ultimate tensile strength. Upon water being first let into the tank, a leak was discovered, which was found to be from a crack between the vertical rows of rivets in a plate in the second ring from the bottom. The sediment in the water soon stopped the leak, and nothing was done about it. On the morning of Feb. 8 the gage showed 60 ft. of water, or 80 ft. below the top, and upon starting the pumps the engineer heard a loud report, and saw ice thrown 10 ft. above the top of the stand-pipe, and it rocking violently. Upon investigation, another crack was found in the same sheet, near the opposite end, from a rivet hole, and about 6 ins. long. The leak stopped as before, and the pipe was used until March 29, when it burst, wrecking itself and the engine house near by. I should say the cause of the failure was a poor sheet of steel, combined with gross carelessness in the continued use of the pipe.

Seneca Falls, N. Y.—This pipe, which burst in 1887, was 130 ft. high and 30 ft. in diameter, of steel plates ⅝ in. thick in the lower ring, with 50,000 tensile strength. The lower ring should have been 1 in. thick to have had a factor of three at the joints. The steel was said to be a coarse, poor grade, as indicated by the fractures. The pipe, when full, weighed about 3,000 tons, or 4¼ tons per sq. ft. of the bottom, and the foundation was said to be of the poorest description.

I think there is no doubt that this pipe was built of too thin plates. The "Engineering Record" gives the strain on the plates between rivet holes as 23,000 lbs. per sq. in. and on the rivets as 25,000 lbs. per sq. in., which I find is the case figured from the dimensions given. This is 50% of the ultimate strength of the plate and 60% of the shearing strength of best rivets, leaving a small margin against chances of defects in work or material.

Franklin, Mass.—On the same day as the above a tank fell at Franklin, Mass. This tank was 40 ft. in diameter and 35 ft. high, with ⅝-in. plates at the lower ring. The plates seem to have been of sufficient thickness, and the failure was in the pedestal or foundation, caused by filling the tank before the masonry was dry. The base was of brick masonry, 45 ft. high and 36 ft. in diameter outside, of two rings of brickwork, the outer 16 ins. thick, and the inner, 12 ins. thick and 12 ft. in diameter. The bottom of the tank was supported by iron I-beams. The pressure per square foot on the brickwork, with the tank full, would have been 7.8 tons; with the amount of water in it when it fell, it was about 5.6 tons per sq. ft. A detailed description of the Seneca Falls and Franklin failures may be found in the "Engineering Record," Nos. 5 and 12, 1887.

Gravesend, N. Y.—Perhaps the most remarkable of all failures was this one in October, 1886. Certainly it was a remarkable stand-pipe. Its total height was 250 ft. Its diameter for the 70 ft. of the lower portion was 16 ft. Between 70 ft. and 95 ft. from the base its diameter diminished to 8 ft., which size it held to the top, 155 ft. more. The first 5 ft. was of ⅞-in. plates; the next 90 ft. of ¾-in., the pipe growing thinner to the top, where the thickness was ¼ in. The thickness seems ample for good metal. The Engineering News stated that the appearance of some of the bottom plates indicated poor and brittle metal. I think Mr. John F. Ward attributed the failure to the right cause, which was that the top was drawn in, creating a tendency in the pressure of the water on the under side of the conical portion to lift the sides from the foundation, which it is reported to have done at the first filling, after which two rings of braces, 24 in each ring, were riveted or bolted to the inner sides and bottom to prevent the sides from rising, or in other words the lower part of the pipe bulging outward. Mr. Ward's letter may be found in Engineering News of Nov. 13, 1886. His figures are: Total pressure on the bottom, 1,448 tons; total weight of water, stand-pipe and fixture, 855 tons; leaving a lifting force of 593 tons. I figure it a little differently. The total lifting strain equals the difference in area of the two diameters, and 16 ft., or 151 sq. ft., which multiplied by the average pressure on the under side of the cone, or 5.23 tons per sq. ft., gives 790 tons total pressure. To oppose this lifting force there is the weight of the water in the annular space under the cone, plus the weight of the sides of the stand-pipe, about 440 tons in all, leaving 350 tons to be carried by the braces to prevent the bottom from bulging. The total strain will come at first on the inner ring, or long braces, 24 in number, making 14.6 tons on each brace. Their section was 2½ × 1 in., with probably a loss of at least 1 sq. in. for rivet and bolt holes, leaving 1½ sq. ins. effective section, or a strain of nearly 10 tons per square inch The braces being an after-thought may have been ordinary rolled bars of a low tensile strength, and it is more than likely that they were attached in such a manner as to bring the strain that two should have carried upon one in some cases, which, giving way, as Mr. Ward says, brought a shock upon the plate to which it was fastened that was too much for its strength, and rupture followed.

The whole design of the stand-pipe was most absurd. To save weight, probably, the pipe was made smaller at the top where the plates were light, and left large at the bottom where the plates should be as heavy as if the full diameter were carried to the top. It was a case of saving at the spigot and wasting at the bung; the storage capacity having been reduced at the top, where needed, and maintained at the bottom, where it was not available; in fact the stand-pipe was upside down. It was this that suggested the form of structure shown by Fig. 8, which is the Gravesend pipe inverted with the proportions changed and the pipe elevated. This failure was described in the Engineering News (Oct. 23, 1886) and "Engineering Record."

Kankakee, Ill.—I will mention one stand-pipe that was overthrown by the wind, that at Kankakee. It was 20 ft. in diameter and 124 ft. high. The first ring was 11-16 ins. thick, which was ample with good metal. The top plates were too thin, being but ⅜ in., and were, in my opinion, the cause of the accident. The tank was anchored by six 1⅛-in. bolts fastened to the second ring of plates, and passing down into the foundation. It was empty at the time; the velocity of the wind was estimated at 60 miles per hour.

The weight of the tank, multiplied by its leverage, one-half the diameter, was less than the wind pressure by its leverage, one-half the height, and the excess came upon the rods, straining them, according to my figures, from 5 to 10 tons per sq. in. with wind pressure of 20 to 30 lbs. per sq. ft. This was when in a normal condition, but when the top collapsed and formed a pocket, at once doubling the effect of the wind on that portion, and throwing the increase all upon the rods, they parted and the pipe fell.

To return to our subject, there seem to be reasons for the use of steel in boilers that do not exist in stand-pipes. As I understand it, it is desirable to keep the plates in boilers as thin as possible to prevent burning, and this the higher tensile strength of steel accomplishes. Steel is also said to be less liable to blister than iron on account of the different structure of the two. I have been able to find no discussion on the comparative merits of the two materials in the construc-

tion of stand-pipes; but of the above reasons for using steel for boilers, neither apply to stand-pipes, and in fact the extra thickness required in iron, owing to its lower tensile strength, is an advantage, for as far as I know iron rusts no faster than steel, nor thick plates faster than thin, and the loss is a smaller percentage of both thickness and strength in thick plates than thin. But the question of cost rules all things, and I am told good steel can be furnished for at least 33% less cost than good iron. If it can be shown that it is a safe material to build with, as probably mild steel is, if properly proportioned, the majority of pipes will be built of that material.

The next element is the thickness of the side plates. There are many formulas, more or less complex, but the question seems simple to me. The pressure on the sides is outward, and due alone to the weight of the water, or pressure per square inch (I refer now to strain tending to rupture the plates vertically), and increases in direct ratio to the height, and also to the diameter. The strain upon a section 1 in. in height at any point is the total strain at that point divided by two—for each side is supposed to bear the strain equally. The total pressure at any point is equal to the diameter in inches, multiplied by the pressure per square inch, due to the height at that point. It may be expressed in a formula as follows:

H = height in feet, and f = factor of safety.
d = diameter in inches.
p = pressure in lbs. per sq. in.
.434 = p for 1 ft. in height.
s = tensile strength of material per sq. in.
T = thickness of plate.
Then the total strain on each side per vertical inch =

$$\frac{.434\ Hd}{2} = \frac{pd}{2};\ T = \frac{.434\ Hdf}{2s} = \frac{pdf}{2s}.$$

There is one element in the above formula to be decided, and one of the most important; that is, what value to give f. This is, of course, a matter of judgment, but there is one point to be settled before we can use our judgment intelligently. It seems to be the general custom in boiler construction to define the factor of safety in terms of the tensile strength of the plates; thus a factor of 5 for 50,000-lb. iron would give 10,000 lbs. as the safe strength. But a moment's reflection will show us that as the joints are the weakest points, in the construction, it is to them that we must look for the safe strength of the work, and we must first find the strength of these, which is dependent upon the strength of the plate, and, when found, may be expressed as a percentage of the strength of the whole plate, and then we may denote our factor in terms of the tensile strength of the plate if more convenient, for we shall then know what we mean by it, and shall not be deceived by a high nominal factor of safety.

Some experiments with specimens of riveted joints show as high as 60% of the strength of the plate for single riveting, and 75 for double. Fairbairn gives respectively 56 and 70%, including friction in the joint. Of course the experiments with riveted specimens, new and made for the purpose, include the friction, but I do not think it is safe to rely upon it at all in stand-pipes. When first built and empty, they are not quite round, generally. When filled, the water forces them into circular shape, and some of the joints must start a little. It is a fact that they do, and cause leaks, destroying the friction in these joints. Again, the joints are liable to rust between the plates where they cannot be painted, also destroying friction. Therefore, it seems safe to disregard friction, and compute the strength of the joint from the section of plate between the holes, and the shearing strength of the rivets. The crippling strength of the rivets need not be considered, as it is higher than the shearing strength. In all dimensions of rivets and plates used in stand-pipes the aim must be to make the strength of the untouched plate equal to the shearing strength of the rivets.

I have calculated the joints on this basis in plates from ¼ to 1 in. in thickness with different sizes of rivets and spacing of the holes, and as a result present the accompanying table of dimensions, which gives the highest results I could obtain. In these calculations I took the safe strength of the plate as 10,000 lbs., and strength of rivets in single shear as 7,500 lbs. The plates not only lose the metal in the holes, but the remaining metal is weakened by punching.

Prof. C. H. Benjamin, of the Case Scientific School, recently described some tests before the Civil Engineers' Club of Cleveland, where he found this loss to be 7.5% for punching over drilling as a mean of all his tests. He found that the loss due to the use of a spiral punch was only 3%.

I find in a book on boilers by W. M. Barr, a series of tests by Kirkaldy, in which the deterioration is 9.5%. In the same book are some tests by Hoopes and Townsend. In these the punched bars showed greater strength than drilled ones. They claim that the result was due to the use of a punch that accurately fitted the die, instead of having the die larger, leaving a conical hole as is usual, their theory being that the plate is subjected only to direct vertical pressure with no tendency to lateral or bursting strains with punch and die the same size.

Mr. Barr also claims superiority for the spiral or shearing punch. With tests of bars punched with both spiral and flat punches, one hole of each in each bar, the bar broke through the hole of the flat punch each time.

Table Giving Dimensions of Riveting and Percentage of Strength of Rivets to Strength of Whole Plate for Different Thicknesses of Plates.

(Dimensions in inches.)

Single, double or triple riveting.	Thickness of plate.	Rivets. Diameter.	Rivets. Length.	Spacing of rivets. C. to edge of plate.	Spacing of rivets. C. to c.	Spacing of rivets. C. to c. diagonally.	P. c. of strength of whole plate.	Punched or drilled.
	A.	B.	C.	D.*	E.*	F.*		Pchd.
Single.....	¼	⅝	1⅛	1	1¼	...	54.5	"
"	⅜	⅞	1⅜	1	1¼	....	52.5	"
Double.....	⅜	⅞	1⅜	1	2¼	2	66.0	"
"	½	⅞	1⅜	1⅛	2⅝	2⅛	66.0	"
"	½	1	2	1¼	2⅜	2¼	64.7	"
"	⅝	1	2¼	1⅜	2⅞	2⅞	63.0	"
"	⅝	1	2⅛	1⅛	2⅛	2⅛	63.0	"
"	¾	1	2⅜	1⅛	3	2⅝	62.0	"
"	¾	1⅛	3	1⅝	3¼	2⅞	61.0	"
"	⅞	1⅛	3¼	1⅜	3¼	3	60.0	Drd.
"	⅞	1⅛	3¼	1⅜	2⅞	2⅞	61.0	"
"	⅞	1⅛	3⅛	1⅜	2⅝	2⅞	59.3	"
"	1	1⅛	3¾	1⅞	3	2¾	59.0	"
"	1	1⅛	4	1⅞	3⅛	2⅞	59.0	"
Triple.....	1	1⅛	3¾	1¾	4	3½	70.0	"

* D, E and F refer to dimensions on Fig. 9.

In my calculations I assumed a loss of 8% besides the loss of metal. In the right hand column of the table are the percentages of strength of the joints in relation to the strength of the plate, which range from 59.5% in 1-in. plates to 65.5% in 5-16-in. plates for double riveted joints and 70% for triple riveted joints in 1-in. plate. It would be better to use triple riveting than to exceed 1-in. plate.

The dotted line C D, in Fig. 1 shows to what height stand-pipes of different diameter may be built of 50,000-lb. metal without exceeding 1 in. of triple riveted, and the dotted line A B on the left of the same diagram shows at what distance from the top of stand-pipes single riveting is sufficient in vertical joints. The percentage of strength in joints is in inverse ratio to the thickness of the plates, as shown by the table. Taking this table as a basis, I assume that it is safe to use 60% of the strength of the iron as the strength of any double riveted joint, but all plates above ¾ in. should be drilled instead of punched, using a factor of five for the strength of the whole plate; or a nominal factor, as it may be called, will give us an actual factor of three at the joints for the strength of the work.

Mr. Howland, in his paper, places the strength of the joint at 75% in double and 66% in single riveting, based upon government tests. He, however, advocates a factor of four, which would make the joints equal to a factor of 3.2 on a basis of 60%. The vertical joints require more care in design and workmanship than any other portion of the structure, and the rivet iron should be of the best quality.

The strain upon the horizontal joints is caused by the weight of metal above the joint, and is small in proportion to the strength of the joint, and is also caused by the pressure of the wind in its tendency to overturn the tank, which would only come upon the tank when it was empty or partially so, and, as I regard it, would not be added to the strain caused by the weight of the metal.

The amount of the wind strain per square inch of metal at any joint can be found by the following formula, in which:

H = height of stand-pipe in feet above joint.
T = thickness of plate in inches,
p = wind pressure per square foot,
W = wind pressure per foot in height above joint,
W = Dp where D is the diameter in feet,
m = average leverage or movement about neutral axis or, central points in the circumference,
or, m = sine of 45°, or .707 times the radius in feet.
Then the strain per square inch of plate =

$$\frac{(H\ w)\frac{H}{2}}{\text{circ. in ft.} \times m\ T}.$$

I have not had time to work out a diagram of strains caused by wind pressure, as I should like to have done; but with wind pressure at 40 lbs. per sq. ft. all pipes built of the thickness called for by the diagram, Fig. 1, up to 30 ft. in diameter are amply strong with single riveted horizontal seams if not higher than the limit given in the list of stability against wind pressures, and if properly secured by guys will be all right for any height. A 30-ft. stand-pipe should be double riveted in the horizontal seams below 100 ft. from the top. Pipes 35 ft. in diameter and over will be safe with single riveted horizontal joints up to the limit of plates 1 in. thick, for the bottom course at least.

The only other strain to be provided for is the wind pressure tending to collapse the top. Mr. Kiersted gives in his paper a formula to find the thickness of plates to resist this, but says it is a crude and approximate method. I think it must be left to the judgment. On the diagram for thickness where the full oblique lines change to dotted oblique and full vertical lines, the thickness of the top for different diameters is indicated. The top plates should never be less than these vertical lines indicate, and must be thoroughly reinforced by a heavy angle iron, well riveted to the plates at the top, and encircling the tank. The length of the full vertical lines show how far down from the top this minimum thickness may be carried. This diagram, which is the left part of diagram Fig. 1, gives the total strain on a 1-in. vertical section of side plates. For all diameters shown on oblique lines, and all heights to 160 ft., the scale of strain is given at the bottom. It also shows the thickness required at any point with material of 50,000 lbs. tensile strength, and a nominal factor of five, which is equal to an actual factor of three at the joints. The scale of thickness in sixteenths of an inch is given at the top of the diagram. I have made inquiries and calculations to find by what fraction of an inch it is most economical to change the thickness of the side plates, and find that it pays to reduce by sixteenths, and it does not pay to make the reduction less than that. The thickness of plate may be read directly from the diagram, and the fraction of a sixteenth should be added rather than taken off when the thickness does not come on the line. The scale of height is divided every 5 ft., as that is the common width of plate, but other widths may be taken by estimates or by scale.

There is no strain upon the bottom plates when resting upon a solid foundation, and the thickness must be left to the judgment. It must be sufficient to calk properly to resist the pressure of the water and also to allow for corrosion on the under side. In computing the diagram of weights I used bottom plates approximately 75% of the thickness of lower ring of side plates in each case.

I think there are no other elements in the general design. Matters of detail must be largely left to individual taste. The bottom connection with the sides is important. Fig. No. 7, A, shows the most desirable form. This brings the weight of the sides well in upon the foundation and also gives greater stability against wind pressure. The side rings are usually made larger at the top to allow the calking to be done on the outside of the stand-pipe and on the top edge of the plate in the horizontal seams. Sometimes the rings are the same size at top and bottom, and every alternate plate is inside of the one next above and below it. This is not quite as convenient in calking but the tank is more likely to be true and round, and has a neater appearance. Perhaps the most difficult work in erection is the beating down of the edges of the plate where three thicknesses meet. In thick plates this is very difficult and they have to be heated in place by a basket fire, and when finished an unsightly spot is left at the joint. I think a better method would be to make the joints as shown in Fig. 1, E. The rings alternate in and out and only the horizontal joints are lapped. The vertical joints are made with butt straps as shown in the figure. This avoids beating down the plates as they are butted at the vertical joints. Although there would be a small increase in weight of metal and of riveting due to the butt straps yet it would result in a material economy in a pipe with plates over ½ in. in thickness, and improve its appearance.

The calking should be done on the outside, except for the bottom of the pipe where the outside cannot be reached. In a cold climate there should be no bars, braces, pipes, or ties inside the stand-pipes. A light ladder seems to be a necessity, but it should be as plain as possible and truly vertical. The diagram, Fig. 1, giving the cost and weight of stand-pipes from 20 to 100 ft. in diameter and up to 160 ft. high, was computed and plotted on the basis of the design suggested in this paper. Ten per cent. was allowed on the weight of all iron work for laps and rivets and excess of metal over the standard thickness. This would not cover the loss from shearing down plates that were not rolled to the right size, but I believe they come from the mill cut to order. The change in thickness was made by sixteenths of an inch and the weight for each diameter carefully computed for every 10 ft. in height and include the bottom and angle iron. The cost is figured as 5 cts. per lb., erected and painted inside and out three coats. This will cover the cost built of best iron at the present time for tanks whose total weight is not less than 50 tons. For weights less than this the cost might be higher. Contract prices vary from time to time, and it is only claimed for the diagram that as close an estimate may be taken from it as can be obtained in any other way, and if the market warrants a different basis than 5 cts. per lb. the result obtained from the diagram may be multiplied by the proper ratio.

If a balcony is required the table of cost at the bottom of the diagram, Fig. 1, gives the cost for different diameters of stand-pipe of a plain balcony with hard pine

floor. Ladders will cost approximately 50 or 60 cts. per lin. ft. and spiral stairs may be built in a neat, plain style for about $5 for each step, including hand railing. The weight and cost is represented on the diagram by curves from the upper left hand corner. The capacity in U. S. gallons is represented by oblique lines from the upper right hand corner. The scale of weight and cost is at the top of diagram, and of capacity at the bottom.

The diagram, Fig. 5, gives the cost of good cement rubble masonry foundations with granite coping 12 ins. deep all around. Three different scales give the cost at $4, $5 and $6 per cubic yard, including earth excavation. These prices probably cover the extreme limit in different localities.

With underground water supplies it is necessary to cover the stand-pipe. A good form of roof is a conical one made of plates ⅛-in. thick, lapped and riveted and attached by iron clips to the angle iron at the top of the stand-pipe, and also to a sufficient number of interior horizontal ribs of angle iron to give it resistance to the wind. Fig. 8 shows the general appearance of this form of roof and the diagram, Fig. 6, gives the weight and cost of it if built without ornamentation. Two scales give the cost at 8 and 10 cts. per lb., the latter price being probably the safer. From the diagrams given with this paper estimates of cost of stand-pipes of the design and sizes given with all parts of the same may be taken in a few minutes that will be as close as any that may be made with hours of computation or obtained in any way except by actual bids.

Elevated Tanks.

I would like to notice a number of elevated tanks that have been built, but this paper is already much longer than I intended it to be, and I will just speak of the Norton water tower of the Liverpool waterworks and a form proposed by Johnson & Fladd, Civil Engineers. The Norton tower is an immense tank or basin of mild steel 82 ft. in diameter, with vertical sides about 10 ft. high, with a bottom in the shape of an inverted dome 19 ft. deep. This is supported by a tower of stone masonry, the whole making a handsome structure about 125 ft. high. A full description of this remarkable tower may be found in the Engineering News of Oct. 3, 1891. The form of tank proposed by Messrs. Johnson & Fladd is illustrated and described in the Engineering News of Aug. 15, 1891. This form of tank has a riveted dome-shaped bottom and is elevated upon a base of steel columns, and makes a pleasing design at reasonable cost.

Fig. 8 shows an elevated tank in which no claim is made of originality in any of its parts, but the whole design is somewhat different from any I have seen, and seems well adapted to economical construction. The bottom is conical, which avoids the necessity for support, except at the point where it is connected with the sides, and is less expensive to construct than a spherical form. The plates where they connect with the sides should be the same thickness as the lower ring of side plates, and may be reduced in thickness toward the center, where the supply pipe enters through a stuffing box of composition, a detail of which is shown by Fig. 7, D. The base is of steel Z-bar columns, of which a section is shown in Fig. 7, C, well braced, and counter-braced to resist wind pressure. The outside line of the column is a parabolic curve made up of straight lengths of the columns. The drawing shows them in lengths of 20 ft., but they may be made shorter with a little more expense for bracing, if necessary, to make a smoother curve. This form of column is well adapted to this work, as the connections are so easily made, and the whole surface is exterior and accessible for painting. The connection with the tank is made to an extension of the side plate, as shown in Fig. 7, F, which shows the form of construction to resist the compressive strains in the sides caused by the water on the conical bottom. The cost of this form of base for different diameters of tanks 50 ft. high is represented by the dotted oblique lines marked "base," on the diagram Fig. 1, and their divergence from the curved lines for the same diameter shows graphically the difference in cost of the base and a continuous stand-pipe. The cost is figured at 5 cts. per lb. for the base, but I am told by a firm that does a large amount of similar work that all of the steel in the base can be erected and painted for 4 cts. per lb.

The beet sugar industry of Wyoming, as shown in Bulletin No. 9 of the Wyoming Experiment Station, University of Wyoming, is in quite a promising state. The average price paid at the factories for beets with 15½% sugar, the average per cent. of 1892, is $4.75 per ton. The average crop per acre of many different fields on some 12 or 14 farms scattered through the state was 12.6 tons, making the average value of crop $59.85 per acre. On many fields the yield exceeded 20%, giving a result of nearly $100 per acre. On the other hand, the average cost of good cultivation at Laramie is $32.50 per acre, with labor at $2 per day, leaving a handsome margin of profit. The beet sugar industry gives every indication of becoming an important one in many states.

WORLD'S COLUMBIAN EXPOSITION.—IV.

The Casino Pier.

To accommodate all water transportation between the Exposition grounds and the lake ports, as well as the steamers from the city, for which latter an exclusive privilege has been granted to the Henry syndicate (Eng. News, Oct. 13, 1892), a large pier has been built out into the lake from the front of the Casino, as shown on the plan in our issue of Oct. 13, 1892. The photograph from which the accompanying view, Fig. 1, is reproduced was taken from the roof of the peristyle, about 100 ft. above the water, about a month before the completion of the work, and the derrick shown is nearly half a mile distant. The pier is specially notable for its

FIG. 1. VIEW OF CASINO PIER (BEFORE COMPLETION): WORLD'S COLUMBIAN EXPOSITION.
B. J. Ashley, Engineer; H. B. Herr & Co., Contractors.

great length, 2,310 ft., and is one of the longest in the world, but the old Piermont pier in the Hudson River, built when the Erie R. R. terminated at that point and connected with steamers for New York, was about two miles long, extending into Haverstraw Bay. The Exposition pier has an area of 13⅓ acres, and its general width is 250 ft. The contract was signed on July 21, 1892, but owing to delay in getting materials, etc., construction was not begun until Sept. 1, and was suspended on Dec. 15. In this time, 136 days, or about 120 working days, at an unfavorable time of the year when the lake is roughest, 3,000 old piles were drawn, 8,000 new piles driven, 1,500 cords of old stone dredged and removed; there were 3,000,000 ft. of lumber and 5,500 cords of stone used, and 151 tons of iron, including nails, drift bolts, etc., were driven. The constructing plant consisted of three pile drivers and one pile puller. The pier is 12 ft. above datum. The average length of piles is 35 ft. driven about 12 ft. into the bed of the lake. The depth of water varies from 8 ft. to 18 ft. The general dimensions of the pier are shown on the accompanying drawings, Figs. 2 and 3, for which we are indebted to Mr. B. J. Ashley, of Chicago, who was the engineer and superintendent. The contract was let to Hiero B. Herr & Co., of Chicago.

The form of the pier is shown in Fig. 2. The cross-sections, given in Fig. 3, show the general construction of the pier. The piles are 11 to 16 ft. apart, c. to c., with 12×12-in. caps, carrying 12-in. floor girders connected by double bridging, and floored with 2-in. plank. Long piles for mooring posts are driven at intervals of 50 ft., and the end of the pier is protected by a row of fender piles 3 ft. apart. There are six rows of tie girders running longitudinally the whole length of the pier and joining the bents together. These tie girders rest on every third row of piles. There are also four rows of piles, not shown on the drawing, driven 4 ft., c. to c., under the center of the pier, for supporting the multiple speed railway or movable sidewalk. The bents are 14 ft. and 16 ft. apart. The average length of girders between centers of bearing piles is 12 ft. Hemlock timber was used throughout. The stone was of a size from masonry rubble to a fair sized rip-rap, from the Lemont quarries, and was brought 28 miles by canal boats and unloaded at the pier in boxes, by a somewhat novel plan. The average cost of stone in place was $6 per ton.

Movable Sidewalk on the Pier.

The multiple speed railway, or movable sidewalk, which has been referred to at various times, and described in detail in Engineering News of Feb. 27, 1892, will, for the first time since its introduction experimentally last year, be put to the test of carrying passengers in great numbers and for actual traffic during the World's Columbian Exposition. The line will occupy the central part of the Casino pier, above described, and the total length of the line will be 4,300 ft., of which 3,337 ft. are double track on tangent, and the remaining 963 ft. are taken up by the loops at each end. The minimum radius of curves in the loops is 64 ft. 9 ins., and the total curvature of the entire line is 696°. The line is level, although the company requested the introduction of grades, that it might prove with what facility heavy grades could be operated by this system.

The line will be covered throughout its length with moving platform cars, of which there will be 351, including ten motor cars. A stationary umbrella shed roof will shelter the passengers from the rain and sun. The 10 motor cars are constructed of iron, and the remaining 341 cars are of wood, and practically of the same construction as the 75 cars composing last year's experimental line. In fact, the changes made in the experi-

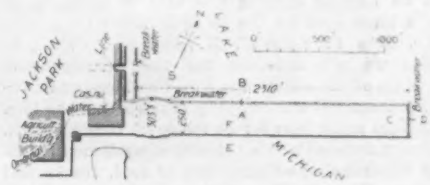


Fig 2. Plan of Pier.

mental rolling stock are so few that these old cars will be incorporated in the pier line. The carrying capacity of the line will be nearly 32,000 seated passengers past a given point per hour. This is claimed to be greater than the capacity of any other mode of transportation in actual use at the present day. Over 5,700 passengers will be accommodated with seats at one time, while no calculation is made of the number that can accelerate their walking rate by walking on the moving platforms. The track will be 2 ft. 10 ins., and the platforms 5 ft. above the floor of the pier, so that seated passengers will have an unobstructed view. A stationary platform, of the same level and placed next to the slow-moving platform, will run the entire length of the road. Passengers desiring to ride on the sidewalk will pass through one of 75 registering turnstiles, provided for that purpose, and placed level with the floor of the pier, and

will mount a low staircase to reach the stationary platform, whence they step on the moving platform. The arrangement is shown in Figs. 4 and 5.

It is estimated that the plant can be operated with 250 HP. in motors, but 300 HP. in motors will be provided. This power will be furnished by electric motors of 15 HP. each, mounted in pairs on the motor cars, which are placed at equal intervals in the circuit. The gage of the track is 45 ins., and the motors are of a type constructed especially for narrow gage roads. The road will be wired below the platforms, and the trolleys conveying the power to the motors will not be visible. The road will be started from a controlling station, situated at a convenient place, and the equipment will also include a number of bells and buttons, placed at equal intervals along the road, which connect with a circuit breaker in the controlling station, and by means of which the moving platforms can be stopped instantly.

Under the concession with the Exposition company, the Pier Movable Sidewalk Co. has the right to charge 5 cts. for carrying a passenger from end to end of the pier, but it is said to be not unlikely that a uniform fare of 10 cts. will be adopted, which will convey no limit as to time and distance, and require no tickets. Much is expected from the display and working of this system at the Exposition. Options have been placed with Eastern parties for further application of the same, and an English syndicate is said to be ready to pay a large sum for the English rights.

Mr. Max E. Schmidt, M. Am. Soc. C. E., to whom we are indebted for the accompanying drawings of the railway, is Vice-President and General Manager of the company constructing the line. Contracts have been let as follows: Rolling stock, Pullman Palace Car Co.; electrical equipment, General Electric Co.; substructure of roof, tracks and stations, Hiero B. Herr & Co.; turnstiles and exit gates, A. G. Spalding & Sons.

The Worthington Pumping Station.

The supply of water for the fountains, sprinkling, fire protection, and for steam boilers and engine condensers will be pumped directly from the lagoon by a plant with a daily capacity of 40,000,000 gallons, installed by the firm of Henry R. Worthington, as explained in our issues of Jan. 16 and 23, 1892. The head on these engines is to be increased in case of fire to 230 ft.

The pump house in which the engines will soon be in place is a two-story brick building of classic architecture, the exterior of which will be ornamented with ten medallion portraits of engineers whose names are historical for their prominence in the construction of English and American waterworks. At the front the building will be open to the roof to give room for the lofty vertical engines. The second story of the rear will be finished off as a reception room, where visitors interested in water-works matters will be made welcome during the Exposition. The pump house is at the southeast corner of the Machinery Building.

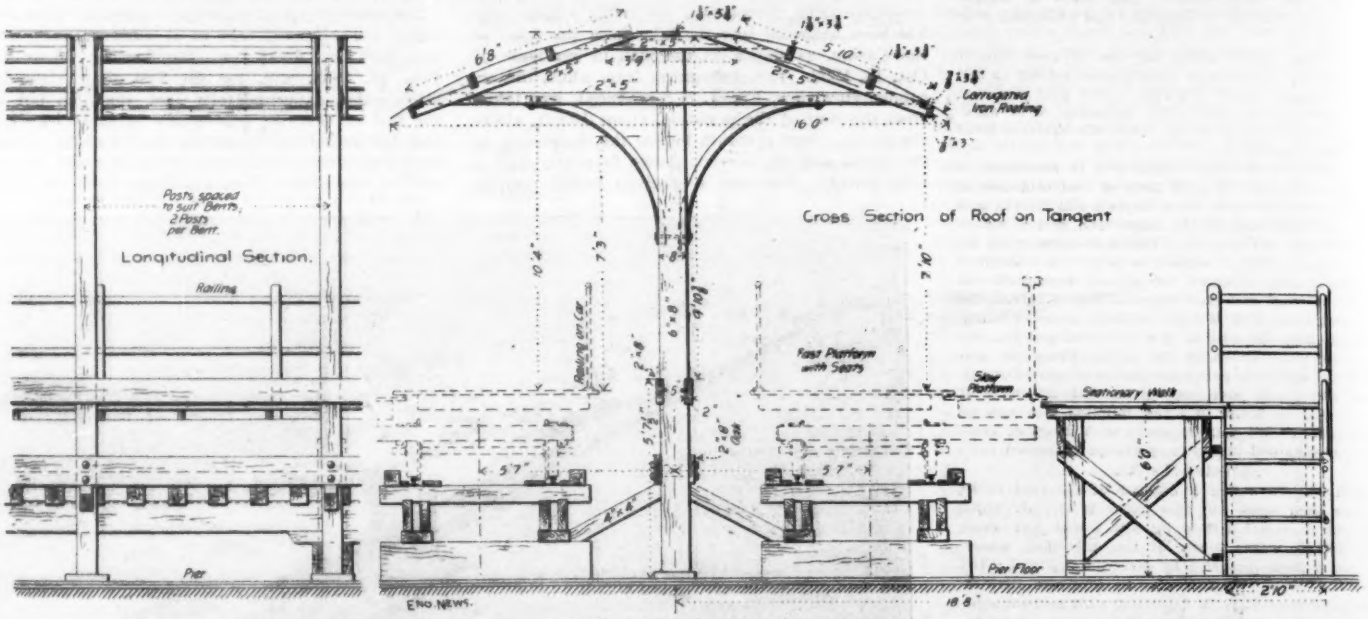


FIG. 4 MULTIPLE SPEED RAILWAY OR MOVABLE SIDEWALK ON THE CASINO PIER: WORLD'S COLUMBIAN EXPOSITION.

The circulating water for condensers will be pumped to the Machinery Building, where a space 100×50 ft. will also be occupied by the Worthington company, which will combine this with a portion of its regular exhibit, and will furnish an assortment of about 40 pumps, 7 of which will be in operation, with an aggregate capacity of 24,000,000 gallons per day, in addition to the main supply.

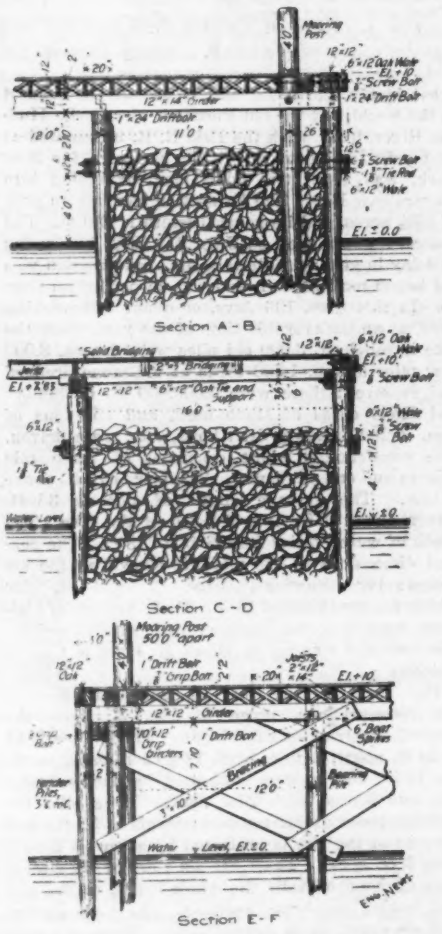


Fig. 3. Cross Sections of Casino Pier.

The two vertical engines in the main pumping stations are shown herewith. The one shown in Fig. 6 is of novel design, being a triple-expansion engine, with two high-pressure cylinders, and with its cylinders arranged to work in pairs. Each cylinder drives a pump plunger, mounted on the same rod with the steam piston, and the cylinders are connected in pairs by horizontal rocking beams, one high-pressure cylinder working with the low-pressure cylinder, and the other with the intermediate cylinder. The duplex feature is adhered to, each side driving the valves of the opposite side. The cylinder diameters are 15, 33 and 57½ ins., plungers are each 22 ins., and all have 38-in. stroke. A 4-in. pipe furnishes the steam supply, and the exhaust is cared for by a jet condenser and independent air pump. The engine is designed for 8,000,000 gallons capacity, and rated at 330 HP. An engine of similar design has been in use for some years at Leavenworth, Kan.

The other vertical engine, shown in Fig. 7, stands on the left of the main entrance, and is the largest, having a daily capacity of 15,000,000 gallons. It is a compound, duplex engine, with double-acting plungers, and is a duplicate of an engine installed at Toledo, O., in 1891, except that it is not fitted with the high-duty attachment. It

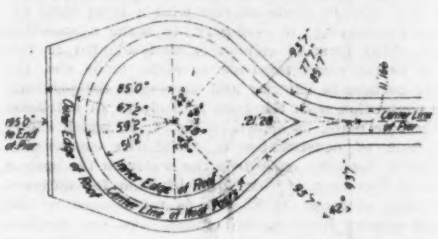


Fig. 5. Loop of Movable Sidewalk on Pier.

is similar in design to the Memphis and Peoria engines illustrated in our issues of Aug. 17, 1889, and June 23, 1892. The principal dimensions of the engine are as follows: Cylinder diameters, high-pressure, 30 ins.; low-pressure, 60 ins.; water plunger diameter, 32 ins.; stroke of all, 60 ins.; pipe diameters, suction and delivery, 30 ins.; steam, 6 ins.; air pump steam cylinders, 14×15 ins.; water, 17×15 ins. The weight of the moving parts is balanced by single-acting plungers, working in cylinders which communicate with a large air tank. The engine is rated at 700 HP.

One of the horizontal engines, rated at 12,000,000 gallons capacity and 500 HP., is a compound high-duty engine of the type which has now become quite familiar in water-works service, and is almost an exact duplicate of the Lowell pumping engine, the

tests of which we reported in our issue of April 16, 1892.

The other pumping engine is the most novel of the four, being a triple-expansion, six-cylinder engine, the high-pressure, intermediate and low-pressure cylinders being mounted tandem. It is designed to run at a piston speed of 350 ft. per minute, developing 190 HP., and delivering 5,000,000 gallons per 24 hours. The stroke, 48 ins., is very long for the cylinder diameters, which are 9½, 15, 25 and 11 ins., respectively, beginning at the high-pressure end. The engine will have piston valves and an independent cut-off on the high-pressure cylinder. The intermediate and low-pressure cylinders will be steam jacketed. An independent condenser and air pump will be used.

The delivery pipes into which the water is forced from all the four engines are 46 ins. in diameter.

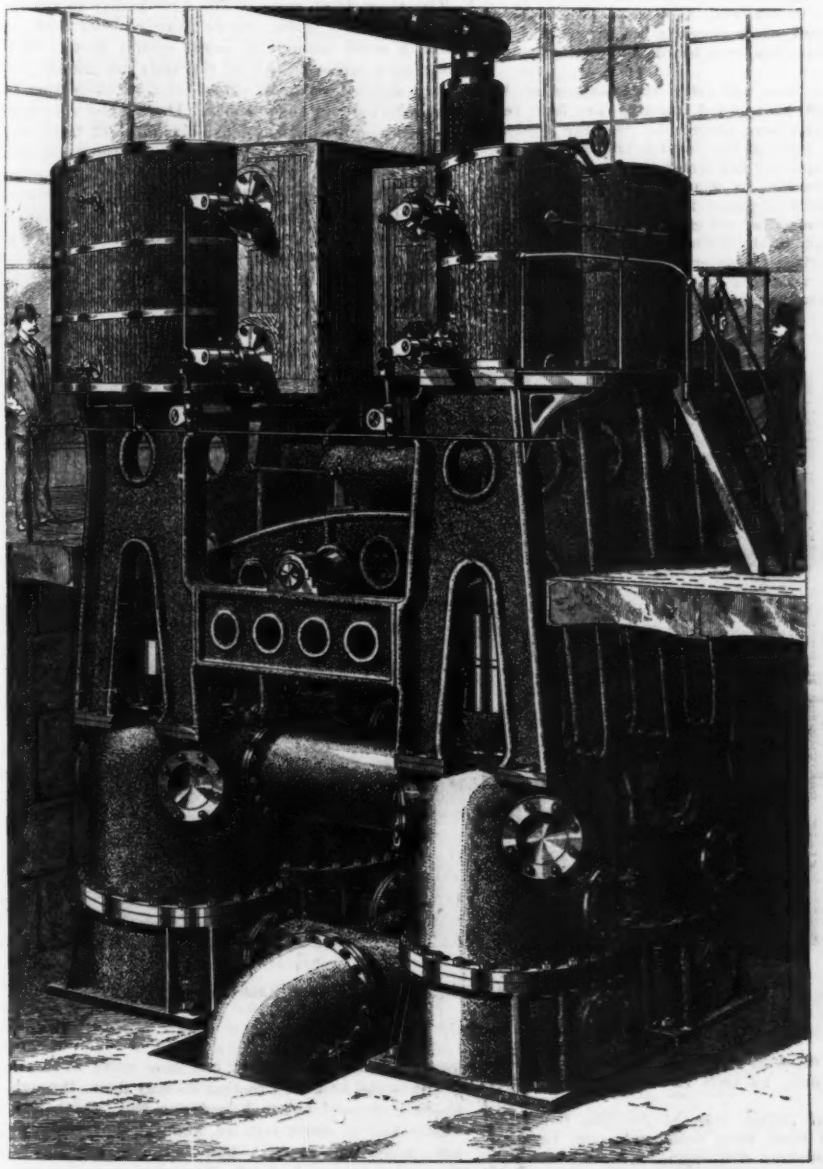


Fig.6. Four-Cylinder Triple Expansion Engine With Rocking Beams; Daily Capacity, 8,000,000 Gallons.

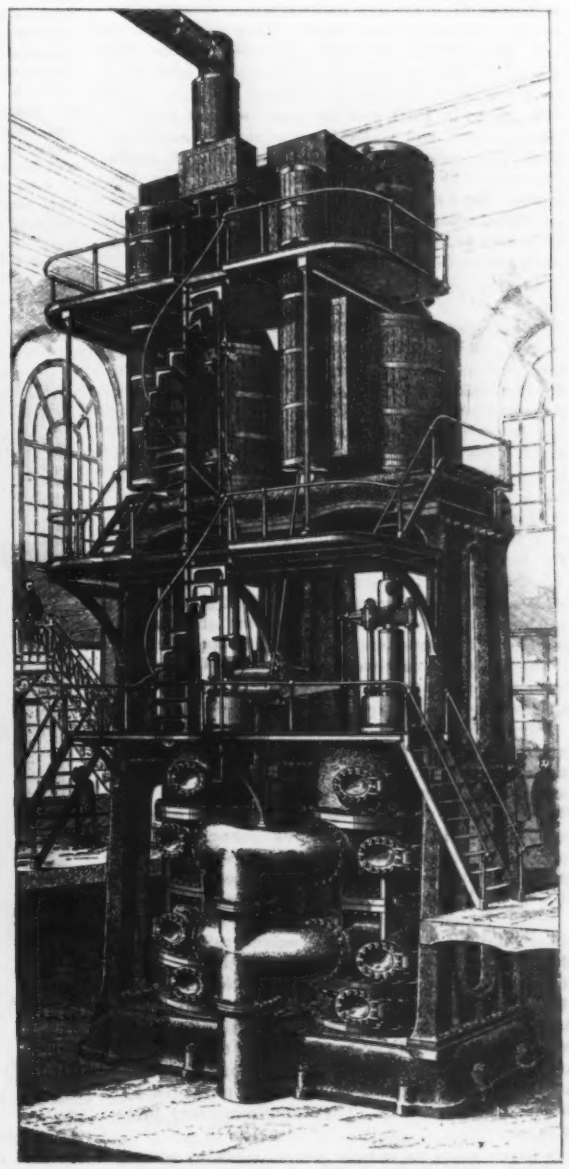


Fig. 7. Compound Duplex Engine, 700 H. P.; Daily Capacity 15,000,000 Gallons.

WORTHINGTON VERTICAL PUMPING ENGINES IN WATER SUPPLY STATION; WORLD'S COLUMBIAN EXPOSITION.

In the center of the building is a well about 18 ft. diameter from which the suction pipes draw the water. The well is connected by a tunnel with the main lagoon.

The total rated power of the four engines is 1,720 HP. The pump house also contains two No. 2 Underwriters' fire pumps.

MASSACHUSETTS RAILWAYS IN 1892.

The current report of the Massachusetts Railroad Commission opens with an excellent discussion of the present status of the railways of the state. The substance of it is that the railway lines of the state are now practically complete. There is no need of additional trunk lines, and future construction will be confined to occasional short branches and spur lines to develop local traffic. The state has now more miles of railway in proportion to its area than any other country of the world, except Belgium, or any state save New Jersey. These railways, as our readers know, are now practically all under the control of seven companies. Twenty years ago these seven companies operated only 600 miles in Massachusetts; and of the 1,400 miles additional which they now hold in the state, about 1,000 miles consists of lines formerly independent. As the commission points out, the public has nothing to fear from consolidations, for "competition has been practically abandoned by legislatures and the public as a theory and method of railroad regulation," and the general tendency of consolidation is to bring better and broader managers into the control of railway corporations.

Boston North Side Union Station.—From the report of E. A. Chesbrough in 1849 to the present day, the removal of the grade crossings and the construction of a union station on the north side of Boston have been problems of ever increasing importance. The plan prepared by Thomas Doane, M. Am. Soc. C. E., and the very similar plan prepared by the engineer to the Rapid Transit Commission are commended by the commission, and it is urged that some such plan should be carried into effect in place of the "half-way" improvement which the Boston & Maine R. R. proposes to adopt.

Passenger Car Heating.—Heating railway trains by steam from the locomotive can now be considered a completed reform in Massachusetts. Practically the only stove-heated passenger cars now in service in the state are those which are in use on mixed trains. The deliverances of various sage railway magnates, who six years ago denounced steam heating as impracticable and visionary, would sound strangely now.

Bridges.—Prof. Geo. H. Swain's report shows that in the five years since the passage of the law establishing a state inspection of railway bridges, 39.4% of the railway bridges in the state have been built new or extensively repaired. Considerable improvement has been made in bridge floors, and it is plain that the Woodstock disaster of 1887 was a salutary lesson in this respect to New England railway officials. Every railway in the state now spaces its ties on bridge floors 8 ins. apart or less, and several roads make a 4 or 5-in. space. In 1887, inside guard rails were standard only on the New York & New England, the Providence & Worcester and the Connecticut River railways, and no guard rails at all were used on the New York, New Haven & Hartford, the Boston & Albany, the Housatonic and the Boston & Providence. Rerailing frogs were in use only on a few Troy & Greenfield bridges. During the past five years all the bridges on the Old Colony and Boston & Maine and a number of bridges on the New London Northern and Cheshire roads have been provided with inside guard rails. The Connecticut River and the New

York, New Haven & Hartford have adopted the combination of inside guard rails with overlapping outside guards, recommended by Professor Swain. The Boston & Albany and Housatonic roads still use no guard rails on their bridges.

An interesting table is submitted showing the increase in weights of the heaviest locomotives in service on each road in the state in 1887 and in 1892. The following table shows the weight and location of the heaviest engine reported of each class:

Class of locomotive.	1887 Weight, lbs.	1887 Location.	1892 Weight, lbs.	1892 Location.
8-wheel.	98,000	N. Y. & N. E.	112,500	N. Y., N. H. & H.
Mogul	105,700	Prov. & Worc.	129,100	N. Y. & N. E.
10-wheel	103,400	Bost. & Lowell.	132,500	N. Y. & N. E.
Consol..	120,000	Bost. & Alb.	130,000	Bost. & Alb.

Grade Crossings.—Massachusetts has done more than any other state toward the abolition of grade crossings of highways and railways, though Connecticut has also done much. Four years ago, in our issue of Feb. 23, 1889, we reviewed the able report of the commission of engineers appointed to investigate the grade crossing question. The law passed in 1890 was the result of that commission's labors, and under its provisions proceedings have been begun for the abolition of 108 grade crossings out of the total of 2,267 within the state. The total cost of removal of the crossings on which reports had been made up to the close of 1892 was $1,384,477, one-fourth of which was paid from the state treasury.

Railway Brakes.—Notwithstanding the severe lessons which Massachusetts railways have received concerning the dangers of deficient braking power, their rolling stock is still very poorly equipped. Only half the passenger engines have driving brakes, and a number of those which have them are equipped with a separate valve for operating driver brake and train brake, the dangers of which have frequently been pointed out. Still, this is a great gain since the Quincy accident in 1890, when investigation showed that only 28% of the passenger engines in service had driver brakes, and only 19% had both brakes operated by one handle. The freight locomotives make a better showing than the passenger, for over two-thirds have driver brakes. Of the passenger cars, only 42% have the quick-action Westinghouse brake; but this, again is a great improvement over 1890, when only 17% of the passenger cars were so equipped. On freight train equipment the showing is fair; 3,639 cars, or 8.7% of the total, are equipped with train brakes.

Automatic Couplers.—Considering their obstinate opposition to this reform, the New England roads make a very fair showing, 12.6% of their freight cars being equipped with M. C. B. couplers. The Boston & Albany has 4,000 out of 6,741 cars so equipped; but the other companies appear to be still hanging back, the Boston & Maine company, for example, still boasting the magnificent total of two M. C. B. coupler cars on its entire system.

Block Signals and Interlocking.—Full credit should be given to the New England railways for their advanced practice in these matters. With the exception of the New London Northern, all the principal roads have now more or less of their lines protected by block signals. Of the 36 grade crossings of one railway by another in the state, 22 are important crossings of one passenger road by another, and all but six of these are protected by interlocking apparatus. The commission very justly says:

> In a few years no railway will be regarded as well equipped or well managed, either in the interest of the company or in point of public safety, which is not fully provided with block and interlocking apparatus.

Steel Rails.—The total steel rail laid in the state is given as 5,272.827 miles, while the total extent of all tracks in the state, including double track and sidings is only 4,043.86 miles. Evidently a large amount of renewals of worn out steel have been made, which the commission has put down as replacements of iron rails. We note that this error is repeated verbatim from last year's report; how much further back it extends we do not know.

The construction of a new steel making plant at Birmingham, Ala., is under consideration by the Directors of the Tennessee Coal, Iron & R. R. Co. It is stated that the desiliconizing process invented by Mr. Benjamin Talbot, of Chattanooga, will be adopted.

A BILL TO REORGANIZE THE CORPS OF CIVIL ENGINEERS, U. S. NAVY.

The following bill was introduced into the House of Representatives by Congressman McAleer on March 1, last. We elsewhere comment editorially upon its requirements:

From and after the passage of this act the active list of officers in the Corps of Civil Engineers of the Navy shall consist of 12 civil engineers and 8 assistant civil engineers, as follows, namely: 2 civil engineers with the relative rank of captain, 3 civil engineers with the relative rank of commander, 3 civil engineers with the relative rank of lieutenant-commander, 4 civil engineers with the relative rank of lieutenant, 4 assistant civil engineers with the relative rank of lieutenant junior grade, and 4 assistant civil engineers with the relative rank of ensign.

Sec. 2.—That all vacancies occurring in the grade of civil engineers shall be filled by promotion from the grade of assistant civil engineers, established by this act, according to seniority, after a physical examination by a board of surgeons in the Navy, and professional examination by a board of civil engineers in the Navy.

Sec. 3.—That from and after the passage of this act there shall be selected annually for four years two cadets, who have passed the requisite academic course of four years at the Naval Academy, from those who show an aptitude and preference for the profession of civil engineering, to whom the Secretary of the Navy shall afford all proper facilities for pursuing and completing a course in civil engineering in some educational institution in the United States of good repute, properly authorized to confer the degree of civil engineer; and any vacancies that may occur in the grade of assistant civil engineers, as established by this act, shall be filled by selection from naval cadets from time to time, as such vacancies occur, in the same manner.

Sec. 4.—Naval cadets selected for the Corps of Civil Engineers shall, upon final graduation, be commissioned as assistant civil engineers.

Sec. 5.—That the active list of officers of the Civil Engineer Corps of the Navy shall be entitled to the pay per annum stated after their respective designations, namely, civil engineers during the first five years after date of appointment, when on duty, $2,400; on leave, or waiting orders, $1,500; during the second five years after such date when on duty, $2,700; on leave or waiting orders, $1,800; during the third five years after such date, when on duty, $3,000; on leave or waiting orders, $2,100; during the fourth five years from such date, when on duty, $3,500; on leave or waiting orders, $2,600; after twenty years from such date, when on duty, $4,000; on leave or waiting orders, $3,000. Assistant engineers during the first five years after date of appointment, when on duty, $1,400; on leave or waiting orders, $1,000; during the second five years after such date, when on duty, $1,700; on leave or waiting orders, $1,200; after ten years from such date, when on duty, $2,000; on leave or waiting orders, $1,400.

SEWAGE PURIFICATION IN AMERICA.

(Continued from p. 220.)

The Effect of Snow Upon the Filter Beds at Summit, N. J.

A visit was made to the Summit filter beds (Eng. News, Dec. 8, 1892), on March 6, to ascertain the effect of the heavy snowfalls of the present winter, which in that locality have kept the ground continually covered with snow for a number of weeks.

At the time of the visit the ground in the vicinity of the beds was covered with about 6 ins. of snow, some of which had been quite heavily packed by rain and thawing weather, and afterwards frozen. The thermometer was a few degrees below the freezing point in the morning, but at noon the snow in the vicinity of the beds was thawing slightly. Most of the beds were entirely covered with snow or ice, or both, and all partially so. The snow filled some of the beds nearly to the top of the banks, while others were covered with ice and a small amount of snow, with a part of their surfaces exposed. All of the beds not wholly covered showed an open space between their surface and the ice and snow above. During the visit sewage was applied to at least six different beds, and in each case found its way beneath the snow and ice. One small bed became filled above the ice with sewage, necessitating the turning of the sewage elsewhere, but the attendant stated that it would soon disappear. Three beds showed the applied sewage running part way across them in channels, with the ice and snow melted above, but on two of these beds the volume of sewage was small. A bed not then in use gave some evidence that sewage had been finding its way down through an underground channel, and one bed, which was nearly full of snow and ice, showed that the sewage, when last applied, had run over the top of the embankment, beneath the snow.

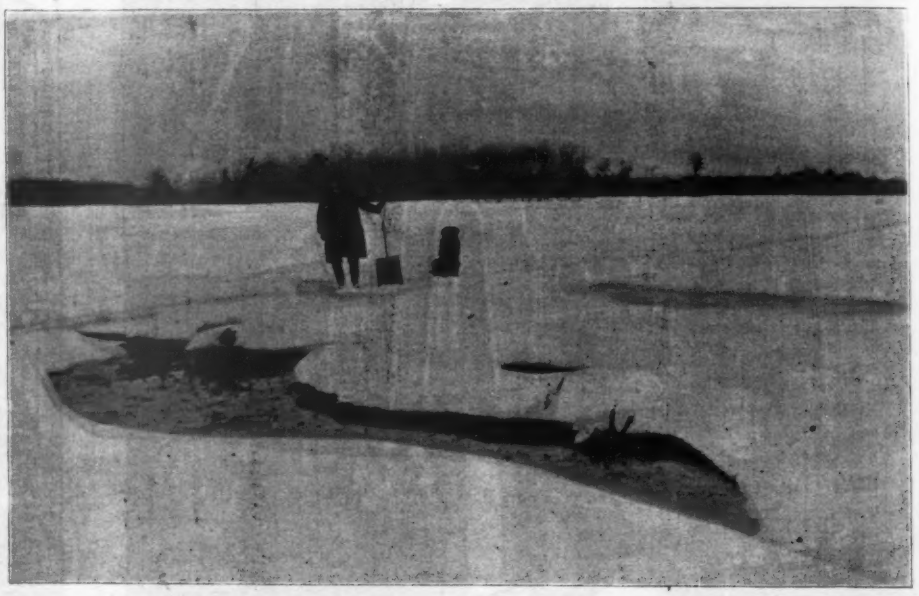


FIG. 77. SNOW-COVERED SEWAGE FILTER BED AT SOUTH FRAMINGHAM, MASS.

The attendants stated that the snow upon the beds had prevented the usual repairs, and thus allowed the channels to form. Channels also form in summer, necessitating watching and repairs.

The smallest beds, and those in poorest condition, are used during the day and carefully watched. At night sewage is applied to six or seven of the beds, there being no night attendance.

The effluent coming from the underdrains appeared to be in good condition, but of course its character could be determined only by analysis.

Mr. John J. Connolly, with one assistant, takes care of the beds. Mr. Connolly stated that the filtering material had not frozen during the winter sufficiently to prevent filtration, and that the snow had not stopped the operation of the beds.

The open space between the top of the beds and the ice gives the air access to the beds and the passage of sewage beneath the ice and snow, as is the case on most of the beds, prevents the chilling which would otherwise result. As there is no settling tank, and raking of the beds has been impossible during much of the winter, some sludge has collected on their surface, but so far as was observed not a great amount. It should be stated that the sewage is admitted to one corner of each bed, and that it has sufficient head to give it a good start across the surface.

On the whole, it seems that the snow on the Summit filter beds this winter, which has far exceeded the usual quantity and duration, adds to the rapidly accumulating proof that the heavy snowfalls of northern latitudes can no longer be considered a valid argument against intermittent filtration. Of course snow and cold reduce the efficiency of filter beds, but provided public water supplies are not affected a poorer effluent can be tolerated in winter than in summer.

The Summit effluent is discharged into the Passaic River at least 20 miles above the point on the river at which the Paterson and Passaic supply is drawn, but both of these latter cities discharge crude sewage into the river only a few miles above the site of the present water supply intake of Jersey City and the recently abandoned intake of Newark. These larger populations ought not to complain if, in exceptional winter weather, the effluent from a comparatively small population, discharged into the river 20 miles above their intakes, is somewhat reduced in quality, while any impurities from Summit could hardly add to the pollution contributed by Paterson and Passaic to the Jersey City water supply.

Snow Upon the Filter Beds at South Framingham, Mass.

The accompanying view, Fig. 77, shows one of the sewage filter beds at South Framingham, Mass., covered with snow and ice. The bed has an area of about ⅞ acres. It received no sewage from the middle of October, 1892, until Feb. 12, 1893. On the latter date there was from 30 to 36 ins. of frost in the ground and 30 ins. of snow on top of it. From Feb. 12 to March 1, when the view was taken, about 50,000 gallons of sewage per day was applied to the bed, going beneath the snow, as can be seen in Fig. 77.

In our issue of Feb. 23, some further details of the effect of frost upon the South Framingham filter beds were given. We are indebted to Mr. John H. Goodell, Chairman of the South Framingham Sewer Committee, for the view and the above information.

THE PRICE RAIL JOINT.

The different forms of rail joints designed by Mr. James M. Price, and put on the market by the Price Railway Appliance Co., of Philadelphia, were illustrated and described in our issue of Oct. 13, 1892, and we have lately received particulars of some tests of the "Spoke" and "Star Girder" joints made at the Riehle testing works, Philadelphia, in February, which we abstract below. The latter joint is called the "Double Girder" joint in the article above referred to.

The "Spoke" joint weighed 32 lbs., without its four bolts, and the "Star Girder" joint, in malleable iron, also weighed about 32 lbs. without its four bolts, while the splice-joint tested for comparison weighed 60½ lbs. for the pair of splice bars, without the six bolts. The figures appear to show less favorably for the "Spoke" than the "Star Girder" joint, but the space between the ties was 13 ins. for the former and 10 ins. for the latter, and Mr. Price states than he can reduce the span of the former to 10 ins., thus reducing the weight to 29 or 30 lbs. per joint, and making the strength and elasticity about equal to that of the "Star Girder" joint. Both of the Price joints show better results at 100,000 lbs. than the splice joint at 70,000 lbs., and while the latter tends to spread under pressure, throwing the strain upon the bolts, the former tend to hug the rail when under pressure.

The following is an abstract of the tables, giving the results under different pressures, the deflection and set being measured in thousandths of an inch.

Table of Tests of Rail Joints.

	Price "Spoke" Joint.			Price "Star Girder" joint.			Six-bolt splice bar joint.		
Load.	Deflect. in.	Set in.	Per cent. of set to def.	Deflect. in.	Set in.	Per cent. of set to def.	Deflect. in.	Set in.	Per cent. of set to def.
5,000	....	...	....	....	....	...	.002	....	....
10,000	.008		...		....	...	.007	....	....
20,000	.027	.009	.33-3	.009	...	...	.016	...	...
30,000	.039	.016	.41	.020	.007	35	.029	.015	.51-7
40,000	.050	.021	.42	.029	.011	.38	.051	....	....
50,000	.062	.027	.43-5	.038	.013	.33	.101	....	....
60,000	.079	.010	.50-6	.051	.020	.39-2	.191	....	....
70,000	1·0	.072	.60	.059	.025	.46-4	.235	....	....
8',000	.153	.105	.6+6	.078	.042	.50-3	.305	...	...
90,090	.175	.119	.68	.106	.064	.6)	.443	.785	.86 9
100,000	.232	.170	.73-2	.152	.109	.71-7	.671	.620	.92-4

PERSONALS.

Mr. Wm. Smith has been elected Borough Engineer of Wilmerding, Pa.

Mr. A. T. Dice has been appointed Superintendent of Signals of the New York Central & Hudson River R. R., with office at Grand Central Station, New York.

Mr. Thomas Tait, General Superintendent of the Ontario & Quebec Division of the Canadian Pacific Ry., has been appointed Assistant General Manager, with headquarters at Montreal.

Mr. James B. Gass, City Engineer and Superintendent of Sewers of Fort Smith, Ark., has been engaged by the City Council to prepare plans for a complete sewer system for Jefferson City, Mo.

Mr. F. A. Dunham, who is Engineer in Charge of Street Improvements, at Olean, N. Y., has been reappointed City Engineer of Sewickley, Pa., where extensive improvements are being made in paving and sewerage.

Mr. J. W. Reinhart, Vice-President of the Atchison, Topeka & Santa Fe R. R., has been elected President of the road, vice the late Mr. Manvel. Mr. Daniel B. Robinson, formerly General Manager of the Atlantic & Pacific R. R., has been elected First Vice-President.

Mr. J. Francis LeBaron, M. Am. Soc. C. E., Chief Engineer of the National Phosphate & Mining Co., of Florida, and said to be the original discoverer of the Florida phosphates, has been appointed also Chief Engineer of the Greenville & Florida Midland R. R., with headquarters at Jacksonville, Fla.

Mr. Herbert M. Wilson, M. Am. Soc. C. E., of the U. S. Geological Survey, is giving a course of 20 lectures on "Irrigation Engineering" at the School of Mines, Columbia College, New York, to senior students. This is said to be the first full course of this subject given at any of the large engineering colleges.

Mr. F. Sargent has resigned as Electrical and Mechanical Engineer of the World's Columbian Exposition, and will devote himself to his private business. Mr. R. H. Pierce, Mr. Sargent's principal assistant, has been placed in charge of the mechanical, and Mr. C. F. Foster in charge of the electrical, department.

Mr. Allen Hazen has been appointed Chemist to the Water Department of the World's Columbian Exposition. For several years Mr. Hazen has been Chemist in Charge of the Experiment Station of the Massachusetts State Board of Health, at Lawrence, Mass., where the valuable experiments on the purification of water and sewage, so often noted in these columns, have been made.

Mr. John E. Thomas, of Kansas City, Mo., died March 7, 1893, after a lingering illness. He was well known as a railway engineer. At the age of 19 he joined the corps of the Union Pacific Ry. Surveys, and later held positions of responsibility on several of the Pacific through lines. He was Chief Engineer of the Atlantic & Pacific R. R., and latterly he was engaged in railway construction.

Col. Geo. E. Waring, Jr., has been called to Memphis, Tenn., as consulting engineer of the Sewerage Department, to inspect its sewers (designed, and originally constructed by him in 1880), and to advise concerning their extension. It is intended to begin the work of sewering the outlying districts of the city, and committees have been appointed in the several districts, by the President of the city, to that end.

Mr. W. Y. Coughlin has been appointed Assistant Engineer of the Baltimore Division of the Northern Central R. R., vice Mr. C. A. Preston, transferred to be Engineer of Maintenance of Way of the Philadelphia & Erie and Northern Central roads. Mr. Preston will have his headquarters at Williamsport, Pa., and succeeds Mr. L. H. Barker, promoted to be Principal Assistant Engineer of the New York Division.

Mr. Edward G. Gilbert, President of the Gilbert Car Mfg. Co., Troy, N. Y., died at Troy, March 7, at the age of 46. He was a native of that city, and gained his education there, except for a period of about a year, which he spent in an engineering school in Poughkeepsie. He also took a course of study at the Rensselaer Polytechnic Institute, leaving there to identify himself with Gilbert, Bush & Co., and on the death of his father, becoming president of the Gilbert Car Mfg. Co., which succeeded Gilbert, Bush & Co.

Mr. James McArthur, of the firm of McArthur Bros., contractors, Chicago, died in that city, March 7. He was born Feb. 5, 1832, near Mount Morris, N. Y. In 1867 he took charge, as engineer, of the improvement of the Kanawha River, and in 1869 transferred his home from Parkersburg, W. Va., to Marietta, O., in order to promote the organization and carry forward the construction of the Cleveland & Marietta Ry. In 1876 he became a resident of Chicago, and a member of the present firm of McArthur Bros. He was a civil engineer of extended experience in the building of railways, canals and other large public enterprises.

Mr. Louis J. Heintz, Commissioner of Street Improvements for the Twenty-third and Twenty-fourth wards, New York city, died March 12. He was born in this city in 1861. He was elected Commissioner of Street Improvements for the Twenty-third and Twenty-fourth wards at the general election of 1890 to serve three years. The office was created by an act of the legislature of that year to meet the demands of the citizens of the district above the Harlem River, in the matter of laying out new streets and regulating, grading, paving and straightening those already opened, constructing sewer lines, etc. The commissioner was made by the statute a member of the Board of Street Opening, ing sewer lines, etc. The commissioner was made by on improvements of this character in the territory above the Harlem River.

Col. William A. Ludlow, Engineer Corps, U. S. A., has been vindicated of all charges made against him in connection with establishing range-lights, etc., in St. Mary's River, and he will be restored to duty. The original question, as noted in our issues of July 7 and Aug. 11, 1892, was one of authority between the Lighthouse Board and the army officers among its subordinates. Colonel Ludlow, as engineer in charge of the Detroit Lighthouse District, was ordered by the board to make a certain disposition of range-lights, etc., along the St. Mary's River. Colonel Ludlow thought that more lights should be used, and that wrecks would result from the limited number ordered. His determined adherence to his ideas resulted in his relief from his office, and the consequent court-martial, with the result given. The present decision is regarded as a practical approval by the War Department of Colonel Ludlow's plans, and will be correspondingly unwelcome to the Treasury Department.

Mr. Wendell R. Curtis, Engineer in Charge of the Construction Department of the Water-Works, Savannah, Ga., died March 7, of paralysis. He was educated at Troy, N. Y., and was employed as assistant to Mr. Wilson, South Boston, Mass., and in several private offices. He was for several years First Assistant to Gen. Theo. G. Ellis, Hartford, Conn., and was Assistant Engineer on the California Southern R. R., in 1883. He held a position in the U. S. Engineer Office, Savannah, Ga., enjoying the confidence of Gen. Q. A. Gilmore, Major Post and other officers of national reputation. In 1889 he resigned from the U. S. Engineer Office, opened private office, and continued his practice until 1891, when he was appointed Engineer in Charge of the new water-works, which position he held at the time of his death. He had just completed a government contract, for wharves, etc., at Sopile Quarantine Station, South Atlantic Department.

NEW PUBLICATIONS.

AMERICAN RAILROADS AS INVESTMENTS. A Handbook for Investors in American Railroad Securities, by S. F. Van Oss; New York, 1893; G. P. Putnam's Sons; 8vo, cloth; pp. 817; 5 maps; price $4.

Books written by Englishmen upon English railways and railway questions are not wanting, as is testified by the works of Jeans, Acworth and others, but this is, so far as we know, the first book making any attempt toward completeness, written by an Englishman dealing solely with American railways and railway questions. The author's purpose in preparing this book was to supply a defect in "existing manuals," which "are too complicated for the average investor, and yet not sufficiently exhaustive to satisfy experts." This attempt to decide between two stools, as often happens, has not been entirely successful, but it is only just to say that under the conflicting requirements this was hardly to be expected. As, however, the book was written primarily for Englishmen, who sadly need correct information on the subject, and, moreover, in a very liberal spirit toward American railways, fault can hardly be found that the impossible was not attained. The author, although confessedly a layman, has an eye to the good as well as the bad points of our railways, despite the Englishman's spluttering horror at the substitution of fare, freight, haul and conductor for bookage, goods, lead and guard, and at the use of tickets "often twenty inches long, and usually three inches broad." We shall attempt to deal with this book in the same spirit of criticism.

By far the greater portion of the volume is devoted to tracing the histories and traffic development and conditions of individual railway systems. For this purpose the country is divided into six groups of states,

viz., the Eastern, Central, Northwestern, Southwestern, Pacific and Southern. Each group is prefixed by a chapter discussing the commercial and physical conditions of the states included, and this is followed by separate chapters for each of the large systems in the group. We may say at once that this appears to us to be by far the most valuable portion of the book. There is also for each group a map, showing by different colors and symbols the various railway systems, which adds greatly to the value of the book. The author is mistaken, however, in supposing these maps to be the "first of their kind that have ever been published," as this journal printed in 1888-9 a similar and much more complete series of maps of the railway systems of the United States, which were afterward published in book form.

It is the first part of the book, however, which will most interest American readers, as here the author discusses the characteristics of our railways and railway methods as a whole, and especially American railways, as means of speculation and investment. After a brief review, his advice to possible English speculators is the historical advice of Mr. Punch on getting married, "don't." As investments, however, he considers the better classes of American railway stocks and bonds unusually safe. As might be expected, considerable space is devoted to the peculiarities of our railways compared with English railways. The enormous traffic, low freight rates, and extent of the large systems are clearly brought out. Especial stress is laid upon the intensity of competition. The writer's views on this point are set forth as follows:

"War is the natural state of the American road, just as of old it was between the cities of the Continent. Indeed, the comparison between the two can be carried on almost to indefinite points. . . . Among states the tendency now is toward consolidation, resulting in peace; so is the tendency among American railroads; and the vaster the systems become, the fewer quarrels will there be. But we are by no means so far yet. The lines are still in a feudal state, and war is universal, though no longer to such extent as of yore."

The natural condition of our railways being war, we should naturally expect the prime requisite of a railway president to be a good general. We quote again:

"A railroad president must not only have the talent of choosing able subordinates; he must also possess a knowledge of all branches of his vast business, and of these nobody has a notion unless he has studied the whole complicated mechanism called a railway. The president determines upon new routes; they must be the best, both from a technical and a commercial point of view. He must build "feeders" in the right place to increase his traffic and to keep competition at a distance. He has to "starve" small lines to buy them cheaply, and at the same time look out not to become "starved" himself. He must enter into traffic agreements to secure through freight, and combine with other lines to attain common ends, to promote common interests, and to defend himself against the enemies of his system. He has to deal with the governments of the states his line traverses, to look after legislatures, appoint trusted agents in the state capitals, and provide them with sinews of war, so that they may fight against hostile bills, or may "have a talk" with legislators if the line wants a new bill itself, and then he must not lose sight of Wall St., mind the bears, and look out that no attack is made upon his control, while at the same time he has to provide all new funds wanted. And then comes the complicated system itself, with lines, rails, rolling stock, passenger traffic and freights traffic, land sales, and so on."

While the truth of some of these statements must be admitted to a certain extent, we are hardly so much impressed with the importance of the office of railway president. In fact we can recall several instances of very satisfactorily managed railways whose presidents have no such combination of qualifications as are here set forth. We are inclined to think that the author's opinions have been influenced by past history rather than by present conditions.

In a chapter on "Some Technicalities," the more technical features of our railways are discussed. Especial praise is given to the comfort and luxury of railway travel in America, and to the speed of our fastest trains, which is considered to be greater than that on English roads, although the average train speed is less in the United States than in England. It is somewhat surprising, however, and not a little amusing, to see the statement that the peculiar construction of our ordinary passenger cars "renders them liable to telescoping." Attention is called to the rapid decline in freight rates and the cheapness of transportation. This is attributed to rapid improvement in roadbed and track, and the reduction of dead weight in our freight trains. In general railway track is considered to be better in England than in this country, but there is railway track in America as good as the best English railways can show, and the author says: "It is probable, however, that before long America will leave us behind, because in that country constant and rapid improvements are effected, while England makes little progress." In respect to the saving of dead load the author makes some remarks which we recommend to the attention to some of our English contemporaries:

"Americans have always endeavored to reduce dead weight to a minimum in order to carry the maximum of paying freight with a given quantity of locomotive power; and the result of these endeavors is that the Americans are admitted to have no equals in the art of moving freights cheaply. I have already shown that in the United States freight is moved 50% cheaper than in England (the real difference is much more than this usually.—Ed.), and this is so because one American locomotive is made to move more paying freight than an English engine. The same amount of fuel and labor which in England are transformed into a given amount of motive power does twice as much in the United States, for not only is there less dead weight, but in addition trains are much heavier and speed is slower while locomotives are stronger and perform more service than their English sisters. . . . . The giant locomotives of the United States are not only stronger and do more work with less fuel, but at the same time cars and engines perform more work than in England, and the difference increases almost annually."

Before leaving the book we must call attention to what appear to us more than usually grave mistakes. Several chapters are devoted to tracing the history of railway developments and abuses and the laws devised to regulate railway operations. We can only touch upon these points. Railway pools come in for general condemnation, as their "aim was to improve earnings by suspending competition." This may be granted to be true if the author means the ruinous competition which preceded their common adoption, but he evidently does not mean this, for he immediately says: "Competition is the soul of trade all the world over; but competition in transportation is the foundation, the first and foremost necessity, of commercial life." The author falls into the old error that competition in railway transportation and trade are alike, whereas they are radically disimilar in important conditions. This is now so well known and so generally admitted that we are surprised to see it questioned in a publication of this nature. The author goes much too far also in his condemnation of the Interstate Commerce law, as in "most respects a failure." In most respects it has been a great success. Undoubtedly if we adhere strictly to the letter of the law there are clauses which work unsatisfactorily, and it is also true that the courts have shorn it of much of its strength, but its value does not rest wholly in its failure to stop abuses, although it has done so to a greater extent than the author imagines. The lesson taught by it is considerably more important than that the improvement in railway business must be left "to time, and to time alone."

THE VOLTAIC CELL; ITS CONSTRUCTION AND CAPACITY. By Park Benjamin, LL. B., Ph. D., etc. New York, John Wiley & Sons. 8vo, illustrated, 562 pp. $5.00.

In this complete and exhaustive work Mr. Benjamin traces the history of the volfaic cell from its first suggestion, by Sulzer, in 1767, through its various forms of development to the present day. He discusses it in its many forms, measurements and capabilities, and closes with a chapter on the various sources of electricity, and another on the bibliography of the cell. The subject of accumulators or storage batteries has four chapters devoted to it. As doubtless the most important problem now under investigation is the production of cheap electricity, and as the voltaic cell is one of the forms in which this end is sought, the appearance of this work is timely, and from its complete record of past experiment and progress it should materially assist in extending the lines of present investigations.

THE ELECTRIC RAILWAY IN THEORY AND PRACTICE. By Oscar T. Crosby and Louis Bell, Ph. D. Second Edition, revised and enlarged. New York, The W. J. Johnston Co. 8vo, illustrated, 416 pp. $2.50.

In this second edition of the work of Messrs. Crosby & Bell, a great part of the first chapter, on general electrical theory, has been rewritten, and corrections and additions of a minor character have been made in other chapters. Two appendices have been added; on motors, with bevel-gear and series-multiple control of motors, and on the method of measuring insulation resistance of overhead lines. The useful appendix treating of the classification of expenditures on electric roads has been extended eight pages by giving various other forms of accounts. The index, too, has been carefully revised and extended. A French translation of this work is now being made, and the first edition has been very well received by the English, French and German electrical papers.

SOCIETY PROCEEDINGS.

NEW ENGLAND WATER-WORKS ASSOCIATION. The quarterly meeting of the Association was held at the Parker House, Boston, March 8, nearly a hundred being in attendance. In the forenoon Mr. Desmond Fitzgerald, M. Am. Soc. C. E., and Mr. F. F. Forbes exhibited stereoptican views showing forms of algae and infusoria found in water supplies. The principal feature of the afternoon session was a paper by Mr. L. M. Hastings, in which he described the method employed by him in estimating the amount of compensation to be paid millowners for water rights affected by taking water from Stony Brook for the city of Cambridge. An abstract of this paper is given elsewhere in this issue. A few experience talks were also given at the afternoon session. The following were elected members of the Association: Watson L. Bishop, Dartmouth, N. S.; William E. Foss, Dorchester; George W. Fuller, Lawrence; Joseph R. Nye, Fairhaven; Caleb M. Saville, Boston; Henry T. Fantom, Rockland, Me.

WESTERN RAILWAY CLUB.—At the meeting on Feb. 21 Mr. Rhodes' paper on the relation of wheel gage and track (Eng. News, Feb. 2) was discussed, and the Secretary was instructed to bring the subject to the attention of the Executive Committees of the Master Car Builders' and Master Mechanics associations. A paper was then read by Mr. Wm. Forsyth, describing tests of several locomotives in heavy fast express service on the C., B. & Q. R. R.; an abstract is given in another column, and the complete paper can be obtained from the secretary, Mr. C. F. Street, Rookery Building, Chicago. At the next meeting, on March 21, this paper will be discussed, and also the question of proposed amendments to the Interchange Rules.

NEW ENGLAND RAILROAD CLUB.—At the meeting on March 8 it was voted to go back to the plan of holding meetings every month. The report of Secretary and Treasurer F. M. Curtis showed that the club had a membership of about 200, and about 13 new members were added at this meeting. The following officers were elected: President, J. T. Chamberlain; Vice-President, L. M. Butler; Secretary and Treasurer, F. M. Curtis; Executive Committee, Messrs. Chamberlain, Adams, Lauder, Marden, Twombly, Butler, Richards, Medway and Stewart.

The subject discussed was air brakes, with special reference to their use on the truck wheels of locomotives. Mr. Lauder detailed his experience on the Old Colony, which has now about fifteen locomotives with brakes on the front trucks. Besides its value as a safety appliance, the truck brake keeps the wheel tires in better condition than formerly, and the engine can be kept in service longer before it goes to the shop to have its tires turned. The first method of application was to feed the truck brake cylinder from the same reservoir which operated the driver brake; but this was abandoned and the truck brake now has a reservoir and triple valve of its own, mounted on the truck frame. The objection to the first plan is that it requires a hose or flexible joint connection between the reservoir and the cylinder, which, if it bursts, releases the brake. If the flexible hose is made a part of the train pipe, its bursting applies the brake. All the brakes on the locomotive and train are applied by one lever.

The discussion consisted chiefly in general commendation of the plan of applying brakes to the trucks of locomotives. At the next meeting, on April 12, experience during the past winter in steam car heating will be the subject to be discussed.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—The 10th convention was held at St. Louis, Mo., on Feb. 28 and March 1 and 2. President Jas. I. Ayer in his opening address said there seemed to be little likelihood of the introduction at any early date of new methods of apparatus which would render obsolete existing plants in which heavy investments have been made. It is probable, however, that long distance transmission will soon come into extended use. The long-felt want of a simple alternating current motor is still unsupplied.

The recent patent decisions have brought anxiety to those who have invested money in the belief that the foundation patents would not be sustained, and satisfaction to those who years ago paid money for the sole right to use within their territory the inventions for which the patents are sustained. The lesson from this is that a reform is needed in patent law and patent litigation which will prevent the inventor being so long deprived of his rights that many shall be led to believe that he has none.

It has always been a serious problem in the electrical industries how to get sufficiently skilled employees to carry on work. A praiseworthy movement for the education of workmen has been started by the organization of the National Association of Electrical Workers, an organization now largely composed of linemen, but intended to include electrical artisans of every class. It is proposed in the local branches of the Association to pursue the study of electrical science with the aid of instructors, technical libraries and reading rooms.

The reading of papers was then proceeded with.

Wrought Iron vs. Cast Iron for Field Magnet Frames.—In this paper Mr. A. D. Adams pointed out the great advantage of wrought iron over cast. The relative case of magnetization of good wrought iron and good gray cast iron is about as 100 to 42. Thus the weight of a cast iron field magnet will be nearly 2½ times that of a wrought magnet of the same type and capacity. Nearly all the leading English makers of bipolar dynamos use forged field magnet frames and the practice will probably soon become common in this country.

Relation of Insurance to Electric Lighting and Power.—Mr. Wm. Brophy in this paper characterized as "silly twaddle" the common newspaper talk concerning dangers of electric lighting. He advised careful inspection of all interior wiring work by the electrical

companies themselves. In building a central station, said he, don't choose the unused end of a flour mill or some similar hazardous location, but build your station with good thick brick walls on a solid foundation. He advocated building wherever possible with incombustible materials, and where wood was used there should be no inclosed spaces. From the discussion in this paper it appeared that the committees of the Association and of the National Board of Underwriters are working in harmony, and that a new set of rules, which will differ, however, but little from those already promulgated (see Eng. News, Oct. 3, 1891) will soon be announced.

Some Experiences with the Alternating Current System.—This paper, by Mr. R. H. Sterling, discussed several practical matters in connection with the operation of an alternating station. He advised a switchboard of marble set well away from the wall with the dynamo bus wires run in in horizontal rows on the back. The front of the board should be divided into panels, each panel representing a feeder. On the back he would place the converter for the voltmeter, the compensating devices and the fuse blocks. This avoids the danger of having a fuse blow in a man's face. Trouble is sometimes experienced from the fuse blowing and melting the fuse block or setting fire to the switchboard. This can be avoided by having all fuses covered with asbestos paper pasted with shellac or silicate of soda. Then when a fuse is vaporized the gases are blown out at each end and the arc is dissipated immediately.

Lead fuses screwed down with a screw head and washer are sure to make trouble, for the soft metal soon flows and makes a poor contact, causing heating and breakage of the circuit. The remedy is to solder to the fuse wire a small flat copper terminal, slotted to slide under the screw head. These are now required by the author on all new work, and are used to replace all blown-out fuses.

A volt and ampere meter is placed on every feeder with a pivot lamp, which will go out and thus call attention to the circuit in case the fuse should blow unnoticed. A new style of changing switch for each feeder is placed on the back of the board instead of on the front, and is worked by a lever extending through a slot to the front. The advantage of this is safety to both switch tender and machinery. With the switches on the front of the board it sometimes happens that when the switch is thrown a violent arc is formed, which leaps from one set of contacts to another, throwing two dynamos in multiple, burning the switch tender's face and hands, and sometimes wrecking an armature.

Concerning lightning arresters, one should be placed on each side of every feeder and the grounding cannot be too perfect. Out on the line it is a good plan to place arresters at the end of each feeder and branch main and scattered at intervals midway on the circuit; they are also a wise protection over a large bank of transformers. A convenient method for grounding arresters out on the lines is to dig a hole at the foot of the pole about 2 ft. in diameter and 3 ft. deep and drive down through it a 12 ft. length of 1¼ in. galvanized iron pipe, with a drive well point on the lower end and a cap on top. The upper end should be driven to about 1 ft. below the surface and the hole should then be filled with finely broken coke. A straight copper wire not smaller than No. 6 should lead from the arrester to the top of the pipe and be well soldered to the latter.

In large stations it becomes necessary to add to the switchboard devices for equalizing the voltage on feeders of varying load. If all are fed directly from the dynamo and the voltage is regulated to suit the feeders with the heaviest load and greatest drop, then the feeders with light load will run at too high a voltage, and lamp breakages will occur. There are two methods of equalizing voltage. In the "booster," invented by Mr. L. B. Stillwell, a converter is so connected to the line that it raises the potential by the amount of the voltage on its secondary circuit. Thus a 1,000-volt circuit may be connected to a converter wound for 50 volts on its secondary and the potential of the circuit will be raised to 1,050 volts. If still higher pressure is necessary, two or more of these "boosters" can be connected in series. The other method of equalizing the potential of the various feeders consists in the use of reactive or choking coils to lower the voltage on the feeders of light load, the dynamo being run to suit the heavily loaded feeders. This is cheaper in first cost than the former method, but more expensive in operation.

A serious annoyance on circuits where two feeders run parallel to each other for a considerable distance is the wavering or "pumping" of the lights, due to the inductive effect of the two circuits on each other. The blame is frequently laid on the engine, in ignorance of the real cause of the trouble. Some different combination on the switchboard will generally effect a cure, but if this fails, transpose the circuits midway between the starting point and where they cease to run parallel by inserting a break arm in each side of the line and joining in the shape of a cross the four ends thus formed.

The discussion on this paper was chiefly devoted to the relative merits of alternating and direct systems. The facts brought out were that the alternating system is practically as flexible as the direct in adjusting dynamos and engines to the load upon them. In one alternating station with a load of 75,000 to 80,000 lamps it was never found necessary to run any station unit at less than 75 to 80% of its rated capacity. In the regulation of voltage on several different feeders connected to one dynamo the alternating system has an advantage over the direct, as the devices described above waste little energy, while with the rheostats used on the direct current system, the extra voltage of the circuits with lighter load is a total loss. The point was also made that location of grounds is more difficult with the direct system where all the feeders and mains outside the station are connected in one network. With the alternating system, each feeder and its system of mains are kept entirely separated from others outside the station.

Prof. Edward R. Weston said that to ascertain exactly what were the losses on an alternating plant was a most difficult matter. In the direct system when the load is light, the losses are very small, but with the alternating system the percentage of loss in the converters increases as the load falls off. He believed that a mistake had been made in this country in employing a high rate of alternation. This will become more apparent as the wires are put underground. The losses will then be greatly increased, but how much, it is impossible to say.

The question of the relative life of lamps on the two circuits was brought up, and it was shown that there was practically no difference. Mr. Kilbourne, of Seattle, summed up the whole matter as follows:

The question as to the relative value of the two systems depends largely on the field you are going to operate in. In Seattle we have both systems and find they do not conflict; and we also find the alternating system just as flexible and in some respects more flexible than the direct system. If you have a station which is so situated that you do not expect to go beyond a certain limited distance from the station, and your load is liable to be light at certain times of the day, and you want to run all day, there is no question that the direct current is the better and cheaper. The chronic condition of most stations is light loads, and the direct system under these conditions is the more economical; but it is impossible to go beyond a certain distance with the direct current, so I think the question largely solves itself.

The sessions on Wednesday were devoted to the reading and discussion of papers on "Thermal Storage," by Prof. Geo. Forbes, and on electrical transmission of power, by Messrs. Bradley, Bell and Stillwell. We abstract the latter papers elsewhere in this issue.

The Incandescent Lamp, from a Commercial Standpoint.—This paper, by Mr. Calvert Townley, was a mathematical discussion, its object being to determine what under assumed conditions was the most economical life of an incandescent lamp. It must be understood that the longer a lamp is used the less is its efficiency, and the more current it requires to produce its rated candle power. Further, the higher the voltage at which a lamp is run, the higher will be its efficiency and the shorter its life. The net result of the investigation was to show an astonishingly heavy loss through the use of lamps of low efficiency. In general, lamps ought to be run at high voltage and should have a shorter life than is now customary, for the waste of power through the increasing inefficiency as the lamp grows old causes a steady loss which soon amounts to the cost of a new lamp. The discussion on this paper was devoted to the effect of the recent patent decisions on the incandescent lamp, and soon became somewhat personal in its nature. It was closed by a motion to refer the matter to the Committee on the Relation Between Manufacturing and Central Station Companies.

The Vulcanizing Process for Preserving and Strengthening Poles, Cross-Arms, Ties, etc.—This paper, by Mr. Harry C. Myers, described the process of wood vulcanizing, or treatment of timber with superheated steam at high pressure, described in our issue of Sept. 14, 1889. Some of the interesting results reported in the paper were an average increase in the transverse strength of the cross-arms of telegraph poles amounting to 18.9%. The life of vulcanized timber is not yet known, as the first specimens treated in 1882 are still sound and in good condition. It is a curious fact that the electrical resistance of most woods is much increased by vulcanizing.

The Morals of Corporations.—This paper by Hon. E. A. Armstrong, of Camden, N. J., defended corporations as important factors in industrial development, and urged that the moral obligations of corporations rendering public service should not be ignored. "Every electric lighting company occupies such a position of trust as to render it morally bound to give a maximum of service at a minimum cost. It is moreover, bound in morals as well as in law to treat with fairness all persons alike. . . . It is the duty of your corporation to use the best methods it knows or can learn, and render the best possible service at as reasonable a figure as it can afford to do it, having a just appreciation of the risk the capital invested sustains, which is entitled to an adequate return. . . . Don't try and find the maximum your customer will stand, but find how little you can afford to charge him, and deal with him on that basis. He will soon find it out, and it will pay you better that the other course, if that is your highest aim."

At the business session on March 2, the Secretary reported a total membership of 250.

The following officers were elected: President, E. A. Armstrong, Camden, N. J.; Vice-Presidents, M. J. Francisco, Rutland, Vt., C. H. Wilmerding, Chicago; Executive Committee, John A. Seeley, New York; E. F. Peck, Brooklyn, N. Y.; A. J. De Camp, Philadelphia; W. J. Morrison, Woodstock, Can.; H. J. Smith, New York; G. H. Baxter, Pittsburg.

The time and place for the next convention were left with the Executive Committee.

BOSTON SOCIETY OF CIVIL ENGINEERS.—A regular meeting was held at the Society's rooms, Feb. 15. Mr. Henry Manley, President, in the chair, and over 100 members and visitors present.

Mr. W. E. McClintock gave an account of the work of the Massachusetts Highway Commission, and at the conclusion a large number of views were thrown on the screen, showing the condition of the roads throughout the state. Mr. E. W. Howe illustrated by lantern views the kind of roads built in the Boston parks and Mr. E. F. Foss, of the Massachusetts Institute of Technology, gave some very interesting views of streets in Chicago and Buffalo.

At the annual meeting on March 15, it is proposed to have a series of short addresses by members, on the relations of the engineer to those with whom he comes in contact.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the meeting on Feb. 21, the president, Mr. M. J. Becker, in the chair, and 29 members present, Mr. Chas. H. Nichols read a paper on "The Howe Truss Bridge," an abstract of which was given in our issue of March 9. At the meeting of the Chemical Section, on Feb. 28, Mr. J. H. Eastwick, chairman, Mr. James O. Handy, secretary, 34 members present, the following communications were presented: "The Apparent Weathering of Pig-Iron," Dr. A. B. Harrison; "Properties of Very Pure Iron," Chas. J. Pedder; "Solubility of Barium Sulphate in Acid Chloride of Iron Solution," Dr. Chas. B. Dudley; "The Segregation of Impurities in Steel," Walter E. Koch; "The Use of Bone Black in Domestic Water Filters," R. Neilson Clark.

COMING TECHNICAL MEETINGS.

SWEDISH ENGINEERS' CLUB.
March 18, Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.

ENGINEERS' CLUB OF PHILADELPHIA.
March 18, 1122 Girard St. Secy., L. F. Rondinella.

COLUMBIAN ENGINEERING SOCIETY.
March 21, Secy., F. W. Hart, Washington, D. C.

WESTERN RAILWAY CLUB.
March 21, Secy., C. F. Street, Rookery Building, Chicago.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
March 21, Secy., E. H. Clark, Pittsburg.

CENTRAL RAILWAY CLUB.
March 22, Secy., S. W. Spear, Buffalo, N. Y.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
March 24, Secy., C. H. McLeod, Montreal, P. Q.

DENVER SOCIETY OF CIVIL ENGINEERS.
March 28, Secy., F. E. King, Jacobson Block.

MONTANA SOCIETY OF CIVIL ENGINEERS.
April 1, Secy., F. D. Jones, Helena.

CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
April 3, Secy., C. L. Annan, City Engineer's Office.

CIVIL ENGINEERS' CLUB OF CLEVELAND.
April 4, Secy., Chas. S. Howe, Case School.

ENGINEERS' SOCIETY OF PHŒNIXVILLE.
April 4, Secy., W. Halliburton.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
April 5, Secy., F. Collingwood, 127 East 23d St., New York.

ENGINEERS' CLUB OF ST. LOUIS.
April 5, Secy., Arthur Thacher, Odd Fellows' Building.

WESTERN SOCIETY OF ENGINEERS.
April 5, Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.

ENGINEERS' CLUB OF MINNEAPOLIS.
April 6, Secy., E. Nexsen, 504 Kasota Block.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
April 7, Secy., E. K. Smoot, 808 Commerce St.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
April 7, Secy., O. Von Geldern, 719 Market St., San Francisco.

WISCONSIN POLYTECHNIC SOCIETY.
April 10, Secy., M. F. Schinke, City Hall.

ENGINEERS' CLUB OF KANSAS CITY.
April 10, Secy., Waterman Stone, Baird Building.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
April 11, S. W. Spear, E. Buffalo, N. Y., Iron Works.

NORTHWESTERN SOCIETY OF ENGINEERS.
April 11, Secy., D. W. McMorris, Burke Block, Seattle, Wash.

NORTHWEST RAILROAD CLUB.
April 11, Ryan Hotel, St. Paul, Secy., W. D. Crosman.

CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
April 19, Wichita, Kan.

NEW ENGLAND RAILROAD CLUB.
April 12, Secy, F. M Curtis, O. C. R. R., Boston.

ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
April 13, Secy., F. W. Mowbray, Norton Building.

ENGINEERING ASSOCIATION OF THE SOUTH.
April 13, Secy., O. H. Landreth, Nashville, Tenn.

NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
April 14, Secy., D. W. Meeker, St. Paul.

BOSTON SOCIETY OF CIVIL ENGINEERS.
April 19, Secy., S. E. Tinkham, 36 Broomfield St.

ASSOCIATION OF ENGINEERS OF VIRGINIA.
April 19, Annual meeting. Secy., J. E. Schick, Roanoke, Va.

NEW YORK RAILROAD CLUB.
April 20, Secy., H. G. Prout, 73 Broadway, N. Y.

ENGINEERS' CLUB OF CINCINNATI.
April 20, Secy., J. F. Wilson, 24 W. 4th St.

SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
April 20, Secy., C. F. Franson, Portland Block.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
April 20, Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.

TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
April 21, 391 Washington Building.

ENGINEERING NEWS

AND

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The sanitary protection of the Croton watershed has been brought before the people of New York city very prominently by the introduction in the New York legislature of a bill authorizing the Commissioner of Public Works to expend a half-million of dollars a year for three years in purchasing such real estate as he may deem necessary for the protection and preservation of the purity of the water supply. This bill is being strongly opposed in many quarters, especially by the New York Academy of Medicine, which includes in its membership many of the most prominent medical men and sanitarians of the city. Dr. T. Mitchell Prudden, in a paper before the Academy, expressed his views on the subject in an admirable paper, a part of which is as follows:

What this city needs, then, is, in my opinion—first, a consistent plan approved by sanitary experts for the safe disposal of town sewage in the watershed and legal and financial power to carry such plans into effect; second, such legislation as shall forbid, under compelling penalties, individual pollution of the water, and an honest and efficient enforcement of that legislation. Finally, the city needs the power and means to acquire, under proper safeguards of individual rights, such real estate as may, in the opinion of sanitary engineers and experts, be necessary to protect the water after the sewage problems shall have been, so far as possible, solved by the more simple and effective measures which sanitary science has made known. To make safe and wholesome again the water supply of this great city no doubt requires intelligence, care, sanitary knowledge, legal and financial power, vigilance and honesty. Just here we should not forget that familiarity with letters, with business, with law, with medicine, with accounts, or with municipal politics does not in itself make any man's opinion on such sanitary problems as these valuable. Nor does it justify him in assuming the functions of a sanitary expert, or of a judge of what is necessary for the protection of the public health.

The suggestion made by Dr. Prudden that a plan, approved by sanitary experts, be devised for the safe disposal of the town sewage within the Croton watershed, is an excellent one. If anything is to be done, and the urgency of the case demands prompt action, it seems that the first step should be in line with the above suggestion. The city of Boston has for years been making systematic efforts to protect its water supply, has diverted sewage and manufacturing wastes from its supply, and has contributed, or agreed to contribute toward the expense of removing or purifying the sewage of three towns in its water supply drainage area. (See Eng. News, Aug. 4 and Sept. 1, 1892, and Jan. 19, 1893.)

It is not to be supposed that the city of New York will succeed in buying up and blotting out whole villages now located in the Croton watershed and polluting the city's water supply, but it is from these concentrated populations that the greatest danger may be expected. A few hundred thousand dollars, judiciously expended, would be sufficient to either remove from the watershed or purify the sewage of the principal villages and hamlets. Coupled with purification or removal of sewage should be legal power to prevent individual pollution. Such power has been secured and is used by Boston, but it has taken and now requires the work of sanitary experts.

The present bill puts a premium on pollution of the New York water supply instead of restraining it, for evidently those who create the worst nuisances virtually put in the highest bid for a share of the half-million a year which it is proposed to appropriate.

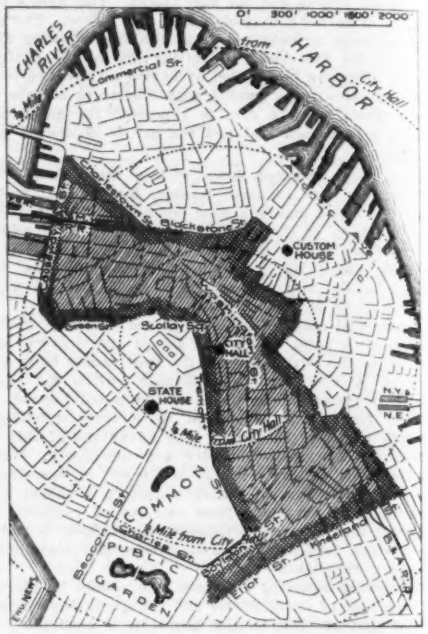
While the purification of the town sewage, at the expense of the city of New York, has been suggested above, it should be borne in mind that it is at least an open question whether this expense should not be borne by the communities concerned instead of by this city. This brings up too large a question for discussion at this time, but one that must be faced, and that resolutely, namely: Are the streams of this country to be used as common sewers, or are they, so far as needed, to be maintained as sources of sanitary water supplies?

Electric lighting companies in London have reduced their rates from 15 cts. per K-W.-hour to 12 cts., with a further reduction to 10 cts. for large users of current. This is equivalent to about 5-7 to 6-7 ct. per lamp hour for lamps of 16 c. p., having an efficiency of 4½ watts per c. p. This is, we believe, considerably below American prices, but the London companies do not furnish lamps to their customers, as is usual here, or do free wiring. The London prices, however, leave a handsome sum to cover interest and repairs on the dynamos and distributing system. Since 746 watts of electrical energy = 1 HP., the sum of 10 cts. per K-W.-hour = 7.46 cts. per HP.-hour, or, for daily service of 10 hours, $272.29 per annum. The cost of steam power in the London electric lighting stations ought not to be over $50 per HP. It is evident that what the electric light consumer pays for is not so much the actual current generated as the cost of transmitting it to his lamps; and in most cases a considerable sum goes to pay interest on capital wasted in unfortunate experiments, or representing something else than cash actually paid in.

The load which is produced by a dense crowd of persons is generally taken at 80 to 100 lbs. per square foot, and is considered to be the greatest uniformly distributed load for which a floor need be proportioned. That this value may be largely exceeded in an actual crowd was pointed out by Prof. W. C. Kernot, of Melbourne University, Australia, in a recent paper before the Victorian Institute of Engineers. In an actual trial, a class of students averaging 153.5 lbs. each in weight were crowded in a lobby containing 18.23 sq. ft., making an average floor load of 134.7 lbs. There was still room to have placed another man, which would have brought up the loading to 143.1 lbs. per square foot. Professor Kernot also quoted from Stoney, who placed 58 Irish laborers, averaging 145 lbs. each in weight, in an empty ship deck-house measuring 57 sq. ft. floor area. This was a load of 147.4 lbs. per square foot. In another test, with 73 laborers crowded into a hut, 9 ft. × 8 ft., 8 ins., Stoney produced a load of 142 lbs. per square foot, and estimated that two or three more men could have been squeezed in. It appears from these experiments that while the figures ordinarily assumed of 80 to 100 lbs. are sufficiently correct for spaces on which there is no cause to induce the collection of great crowds, larger figures, say 140 or 150 lbs. per square foot, should be used for railway stations and platforms, entrances and exits to places of public assemblies, or of office buildings, bridge sidewalks, pavements over vaults, and other places where dense crowds are likely to gather.

THE BOSTON RAPID TRANSIT SITUATION.

For some years past the people of Boston have been in an agitated state of mind over the question of transit facilities and the relief of their "congested district," a little area hardly more than one-fourth mile wide (east and west), by a mile or so long (north and south), as shown in outline on the following little sketch, but which is certainly now much congested. Through this district run lengthwise two main thoroughfares, Washington St. through the heart of it, and Tremont St. rather to one side of it, but still almost in the heart of it, except where it borders on the Common. Both of these thoroughfares greatly need relief, since both of them (but especially Washington St.) are rather narrow and crooked, and have a good deal of wagon traffic in addition to the almost continuous procession of electric street cars, which handle the greater part of the suburban, as well as city traffic,



Map of Boston Showing the Congested District.

though the steam railways of Boston also handle an enormous local traffic. The growth of both the steam and street railway traffic for the past 20 years, with what is called the "metropolitan" population (that within ten miles from the Old State House), has been as follows, in round numbers:

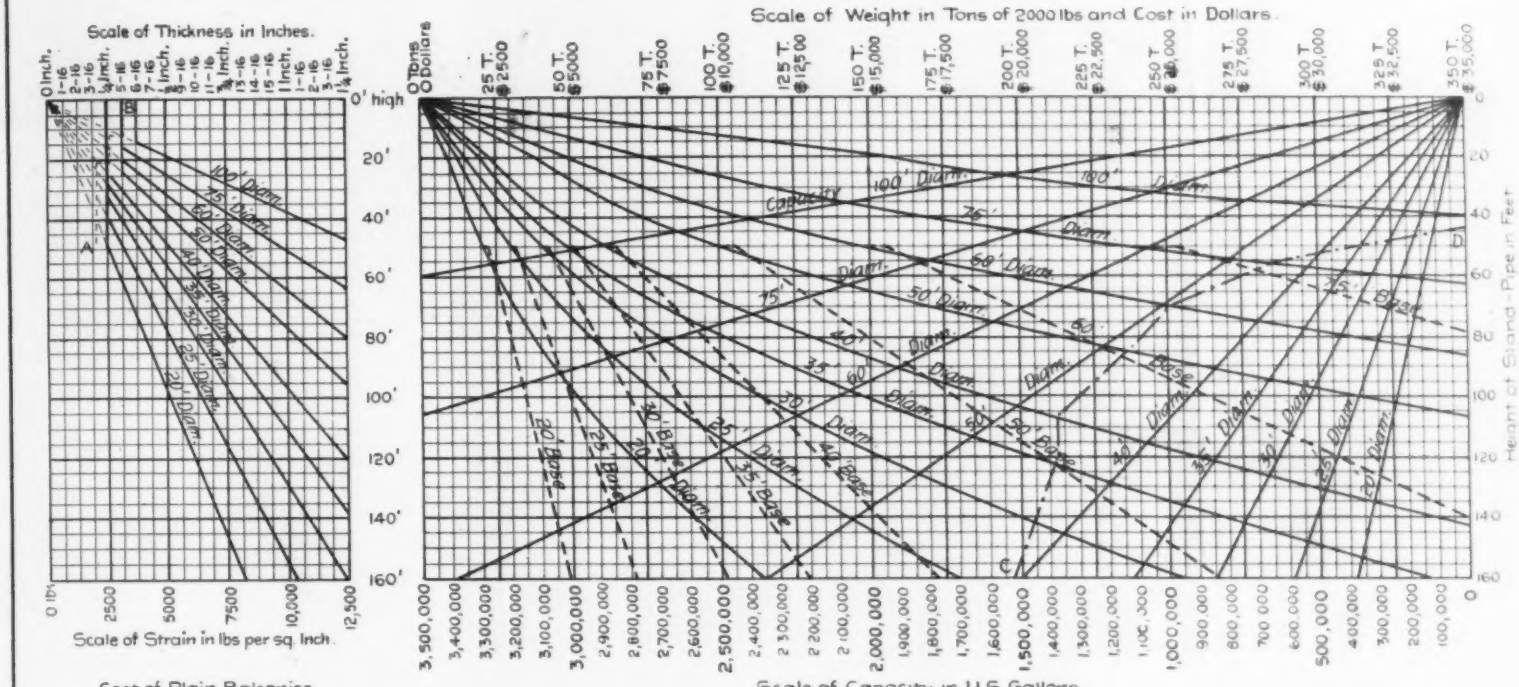
	Popl'n.	Steam r'y pass'rs.	Street r'y passr's.
1871.....	515,000	17,000,000	34,000,000
1881.....	665,000	25,000,000	68,000,000
1891.....	850,000	51,000,000	136,000,000

These figures follow, and even exceed, the too little understood law which lies at the very foundation of all judicious management of transportation, that traffic increases rather as the SQUARE of the tributary population than directly therewith; in other words, that doubling the tributary population quadruples instead of merely doubling the traffic, and proportionately for greater or smaller increments.* The total number of trips per inhabitant, and the total number of trips per inhabitant per 100,000 of other inhabitants has been as follows: If the growth of traffic were exactly as the square of the tributary population, the last column would be constant, but it will be seen that at Boston (as at New York) the traffic has grown even faster than as the square of the population:

	Trips per inhab't.	Do. per 100,000 pop'n.
1871.....	99	19.
1881.....	140	21.
1891.....	220	26.

The corresponding figures for New York in the last column have been since 1870 nearly constant at 15 to 16, this including the strictly intramural traffic only, of elevated and surface lines. If the steam railway traffic were included for the entire district this figure would probably be about the same as at Boston, or 20 to 25.

*For a demonstration of this law, and many other statistics of traffic proving that it is a law of general application, see Wellington's "Economic Theory of Railway Location." Chap. XXI.


Scale of Thickness in Inches.
Scale of Weight in Tons of 2000 lbs and Cost in Dollars.
Scale of Strain in lbs per sq. Inch.
Scale of Capacity in U.S. Gallons
Height of Stand-Pipe in Feet
Scale of Depth of Foundation in Feet
Angle of Roof with Horizon.
Capacity
Diam.
Base

Cost of Plain Balconies

20 ft. Diameter		$ 165.00
25	" "	" 205.00
30	" "	" 250.00
35	" "	" 285.00
40	" "	" 320.00
50	" "	" 410.00
60	" "	" 500.00
75	" "	" 615.00
100	" "	" 820.00

Data.

Tensile Strength of Material	= 50,000 lbs.
Nominal Factor of Safety	= 5
Actual " at Joints	= 3.
Cost of Material erected	= 5 cts. per lb.

Strain Formula.

$$S = \frac{(Hd)\ 434}{2}$$

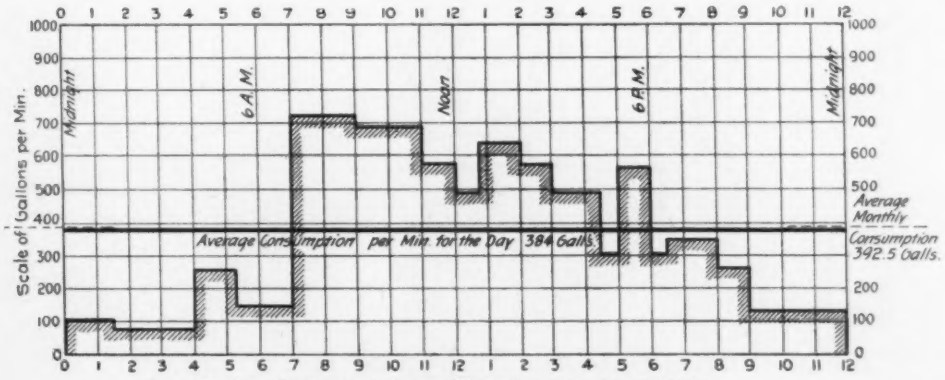
$$T = \frac{(Hd)\ 434 \times factor}{2M}$$

H = Height in Feet
d = Diam. = Inches
S = Strain in lbs. per vert. Inch of Metal on each Side.
M = T.S. of Material.
T = Thickness of Plate in Inches.

Explanation.

Full Curved Lines from Upper Left Hand represent Weight and Cost of Sides and Bottom.
Dotted Straight Lines represent Weight and Cost of Framed Steel Base.
Full Straight Lines from Upper Right Hand Corner represent Capacity in U.S. Gallons.

FIG. 1.



Consumption of Water per Min. at different Hours on June 20. 1892, Woonsocket, R.I.

FIG. 4.

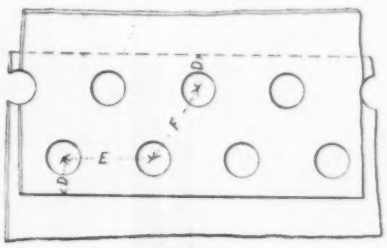
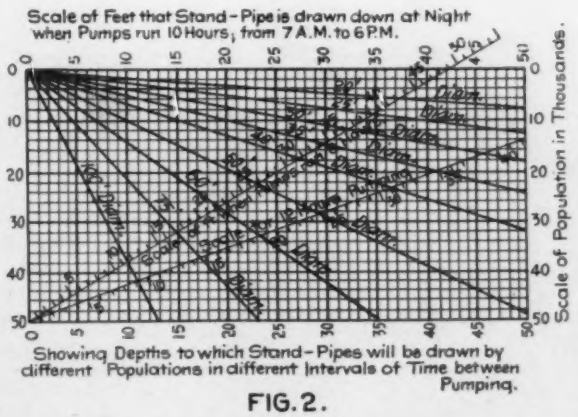
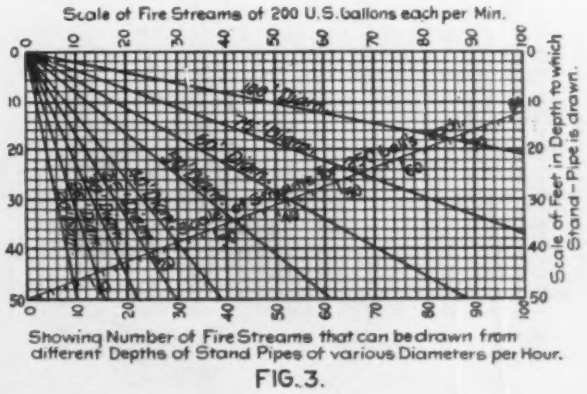


FIG. 9.


Scale of Feet that Stand-Pipe is drawn down at Night when Pumps run 10 Hours, from 7 A.M. to 6 P.M.
Scale of Population in Thousands.

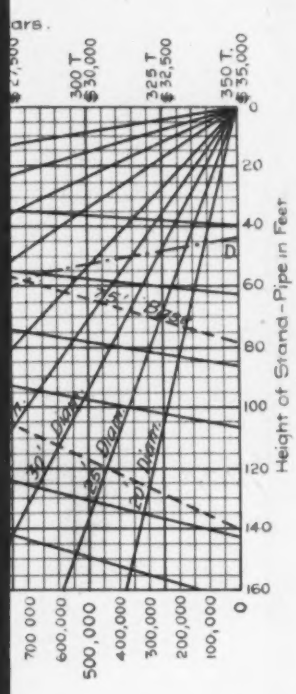
Showing Depths to which Stand-Pipes will be drawn by different Populations in different Intervals of Time between Pumping.

FIG. 2.



Showing Number of Fire Streams that can be drawn from different Depths of Stand Pipes of various Diameters per Hour.

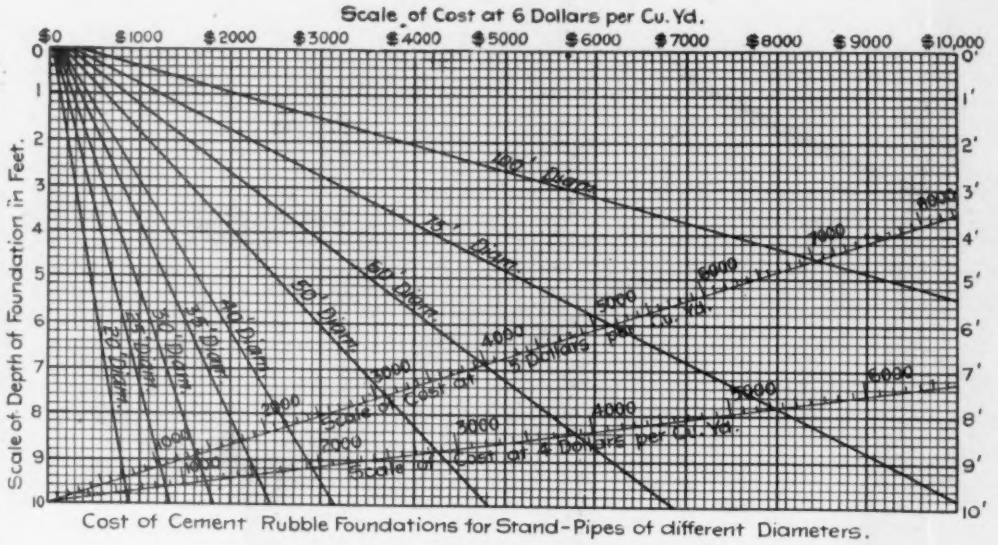
FIG. 3.



Explanation.

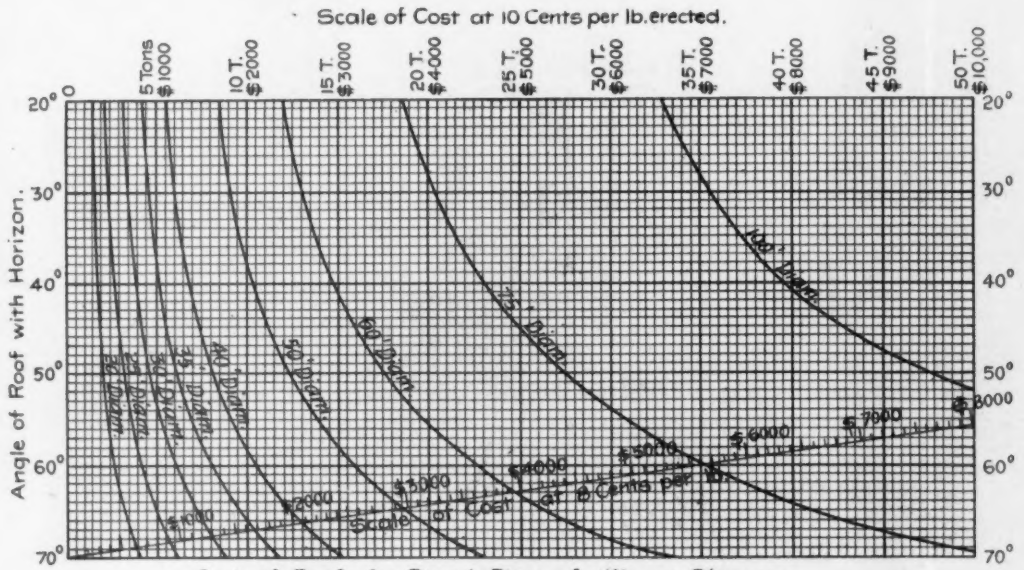
urved Lines from Upper Left Hand
esent Weight and Cost of Sides and
m.
d Straight Lines represent Weight
Cost of Framed Steel Base.
Straight Lines from Upper Right Hand
r represent Capacity in U.S. Gallons.

.9.



Cost of Cement Rubble Foundations for Stand-Pipes of different Diameters.

FIG. 5.



Cost of Roofs for Stand-Pipes of different Diameters.

FIG. 6.

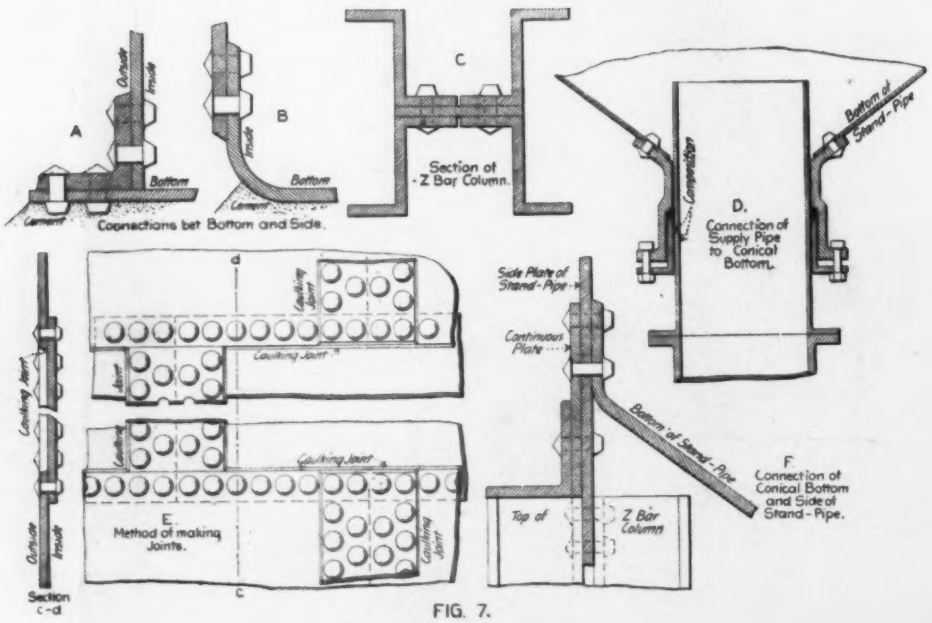


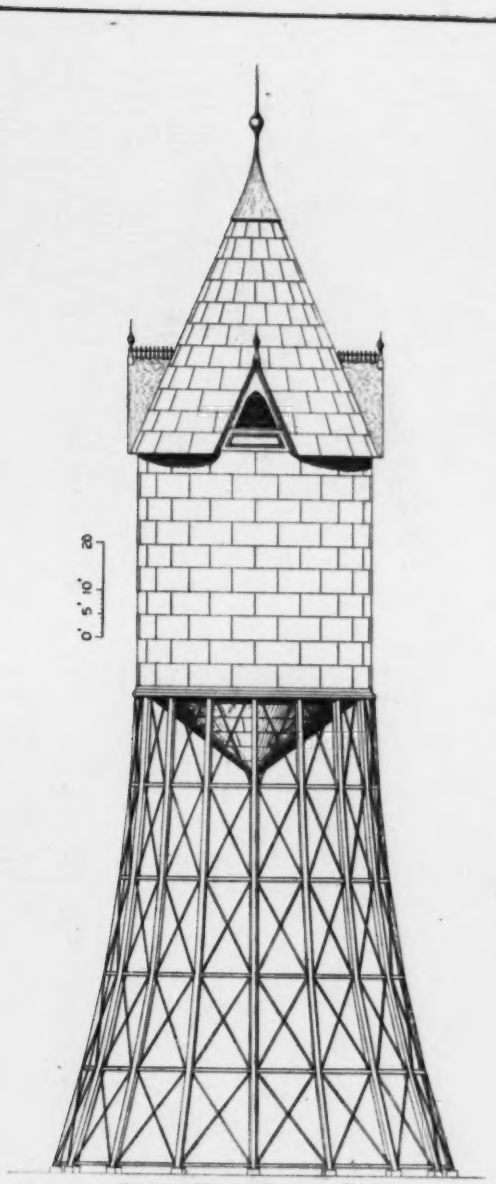
FIG. 7.

Scale of Feet in Depth to which Stand-Pipe is drawn.

Hour.

DIAGRAMS FOR
STAND-PIPES
OF CON

By Freeman



Elevated Tank, 50' Diam., 50' high.
Framed Steel Base, 100' high.
FIG. 8.

Balcony and Railing.
FIG. 8a.

FOR USE IN DESIGNING
O-PIPES AND DETAILS
F CONSTRUCTION.

Freeman C. Coffin, C. E.

These figures prove to demonstration that there is a real problem before Boston; that things present are only a foretaste of things to come, and that it behooves them to be up and doing, and to plan for the future as well as the present. In 1891, therefore, the commonwealth very wisely directed that a rapid transit commission of eight should be appointed, and very unwisely, but very naturally, so constituted it that, with only a single exception (the city engineer, ex-officio), it was made up exclusively of lawyers and other eminent citizens who had not prejudiced their minds by any previous knowledge of, or experience with, the particular class of problems involved. Had the respective authorities been asked to appoint a body of eminent musicians to report on a medical question they would probably have seen at once that it would be a silly procedure, but transportation problems are not yet recognized to be equally incapable of amateur handling. Almost every citizen forms his own plans freely and confidently, and cannot be convinced of their folly by whatever arguments.

The report of this commission, rendered April 5, 1892, was about what might have been expected from such a body; painstaking beyond description, embodying in it almost every fact which could be needed in studying the problem (it is an octavo of 300 pages, and with 31 large folding plates), with much sensible general discussion, but with hardly a sensible word in it in the way of definite recommendations. They recommended in brief (1) to spend $12,079,000 in street widenings, chiefly on streets belting about the congested district, but not in it; (2) to remove all street cars bodily from within this district if the public would stand it, but as they probably would'nt, to come as near to this as possible; (3) to build a four-mile three-track elevated belt line round about the congested district and across a corner of the Common, at a cost of $8,500,000, including land damages, "which might, of course, fall short of the actual expense." They also recommended that the steam railway terminals should be "completely readjusted," which may, or may not, have been wise. We have given scant attention to that side of the problem; but as every one of the present railway terminals is within half a mile of the heart of the congested district, their present defects are not very crying ones in respect to rapid transit, to say the least.

The other recommendations, in our judgment simply propose to spend a vast sum of money for a minimum of benefit, if, indeed, there would be any balance of benefit if all were done as recommended; and it is, therefore, a fortunate fact that they have fallen flat, and that there does not appear to be the least probability of their being adopted. In the first place, belt lines are proved by the experience of the London underground lines, as well as by common sense, to be a financial fallacy. The people will not go out of their way to use them, even if the distances to be traveled are considerable. In Boston, the distances are so inconsiderable that any corporation which built upon the lines which the commission recommended would speedily starve to death. The commission naively suggest that by spreading out their lines into the districts where the crowd is not they will persuade the crowd to follow them, and so relieve the congestion. They will not, and they could not, do anything of the kind. The crowd will simply leave the new lines severely alone and stick to the surface railways, as the Londoners stick to their omnibuses and cabs.

In the second place, experience and reason both indicate that the only proper field for elevated railways is in densely settled city districts through which the average passenger has to travel from three to five miles, at least. In Boston, especially, which has such exceptionally admirable and complete steam railway service, it is quite certain that the bulk of the travel of over five miles' haul will continue to go by the steam railways. On the other hand, the exceptionally good and rapid (albeit somewhat dangerous) electric street car service which Boston now enjoys, and which has plainly come to stay, makes the electric cars exceptionally formidable competitors for the traffic of less than three miles' haul. In our judgment, with certain inexpensive betterments to be considered later, to reduce the danger and at the same time increase the speed of this short-haul service, they would be absolutely destructive competitors for all this short haul traffic.

There remains, therefore, only the traffic between three miles and five miles' haul which can be rationally expected to go in any quantity to elevated lines; but here comes in a further fact. At hardly any point on the three miles circle is there any city population, properly so-called. Practically all of it is distinctly suburban, and much of it is quite sparsely suburban. Who is going to build elevated lines out to such a district, and how much traffic would it give? Ten different radial lines would have to be built to strike the three mile circle at points a mile apart!

Nevertheless, we do not dispute that on certain routes elevated lines may be needed and highly useful even now, and still more in the future. But it is quite certain that they are not, and never will be, a needed or effectual general remedy for the evils of the situation.

Let any one study the effect of even short distances to destroy elevated traffic as evidenced in the comparative traffic of the second Ave. and Third Ave., or the Sixth Ave. and Ninth Ave. lines in New York, and they will see a new light on this subject; but granting that all of the three- to five-mile traffic would go to elevated lines, how much of this is there?. The admirable and masterly presentation of facts bearing on the problem in City Engineer Jackson's report (one of the best reports of the kind we have ever seen) enables us to answer this at once. These are within a radius of

	No. inhab'ts.	P. c. of total.
1 mile	112,000	13.6
2 miles	314,000	38.1
3 miles	473,000	57.2
5 miles	623,000	75.5
8 miles	721,000	87.6
10 miles	825,000	100.0

In other words, 57.2% of the population live so near the city that they will mostly use the electric cars; 24.5% of them live so far out that they will mostly be better served by the surface railways, and 18.3% only, or 150,000 people in all, live where they are likely to be better served by an elevated line near to them, and they on an area of 35 sq. miles, so that the average population is only 4,300 per sq. mile, at which rate Manhattan Island complete would harbor less than 80,000 people!

The attempt to remove all, or most of the surface cars, from within the congested district would be even more unfortunate and injurious. Why do the surface cars run in there now? For the mere sake of hauling the passengers a little further for the same fare? Not at all, but only for the vulgar reason that by so doing they pay better; in other words, get more passengers; in other words, are a greater public convenience. The idea that by simply stopping the surface cars on the edge of the crowded district their patrons can be compelled either to walk the rest of the way, or to climb up the stairs of an elevated railway to ride another half-mile or so to another point also on the edge of the territory where people want to go, and not in the heart of it, is utterly chimerical and absurd. The public would not, and ought not to permit it, after experiencing a little of its discomforts, while it would make immediate and heavy inroads upon the revenues of the West End Railway Co., which single company now controls all the street car lines entering Boston, a fortunate fact in seeking to make plans for a readjustment to remedy the present difficulties.

Still less would it be possible to keep the street cars out of the crowded district if the third feature of the commission's plans, extensive widening of streets, were carried on. This would make room for many more surface tracks on streets which are now crowded to repletion, and the inevitable effect would be a steady and persistent pressure from both the public and the railway company to lay still more tracks in these streets, which would in the end be successful.

Even if this were not so, there is another fact which would nullify the relief sought from the street widenings. All of the immense suburban population of Boston, say 500,000 people, are within easy driving distance of the heart of the city, and they have only a mile or so of paved city streets to drive over to get there, in most cases. The great number of cars in the narrow streets has driven this class of travel almost out of the city, and it has also greatly discouraged or driven off to other streets the ordinary city teaming. No one who remembers Boston in the sixties can fail to notice the great decrease of this class of travel on the streets; but with widened streets it would certainly tend to increase up to the limit when the congestion became as bad as before, there being almost unlimited opportunity for the growth of this traffic.

It is not surprising, therefore, that the report of the commission fell very flat. Only one result has followed, and that an unfortunate one. A large fraction of the public has become deeply imbued with the two mistaken notions that they ought to have elevated railways somehow, and that they ought to remove all street cars from the crowded district; the very things they ought not to do. In the meantime, as things have been growing daily worse, the president and creator of the West End Railway Co., Mr. H. M. Whitney, who has recently become still more famous as the head of the Nova Scotia coal mine syndicate, brought forward a plan of his own for a six-track tunnel and subterranean terminus on and under Boston Common, as shown and described on another page. It has excited an intense feeling of opposition in the city, on the very just ground that it would ruin the Common as a park, practically making a "porous plaster" of it by its multitude of holes designed to light and ventilate the subterranean works. From one point of view the public excitement is illogical. Mr. Whitney's plan is in every way a less objectionable invasion of the Common than the Rapid Transit Commission proposed, for they were going to have a combined elevated and tunnel line over the same route, which would have a far more hideous effect; but the contrast between the excitement over Mr. Whitney's proposition and the perfect calm when the commission's propositions were made known is probably explained by the fact that Mr. Whitney was known to be a man of business who meant business when he proposed anything; and the same view was not taken of the commission's suggestions.

Certainly the feeling in Boston is now very intense against any further invasion of the Common, and in our opinion justly. But the practical objections to the proposed plan are so great as to make it needless to raise the sentimental issue. In the first place, the rows of 6-ft. holes, 30 ft. between centers, would be all but useless for lighting, and worse than useless for ventilation. Electric lighting would have to be the main reliance in any case, and to secure any kind of decent ventilation the first necessity would be to close those openings and introduce some form of fan ventilation, which the existence of electric power everywhere in the tunnel makes easy and inexpensive.

That done, and with the work of construction done without destroying the old trees on the route, the objections of the citizens to the project on the ground of defacement of the Common would vanish. There is no objection anywhere to tunnels which do not deface the surface, and probably a limited number of stairway entrances could also be arranged for. But supposing all this done, and the work (which would certainly cost several millions) turned over gratis to the company, it still seems to us so disadvantageous to all concerned that they would all agree to fill it up and abandon it and do something else in preference. It attempts to concentrate at one point, and that a comparatively remote one, outside the crowded district, and approachable only by narrow sidewalks and 25 to 30 ft. of stairway, practically all the street car traffic of Boston. Its effects upon street car revenues and public convenience, as compared with present conditions, would be alike destructive.

What then can be done? It is not our place to say with any detail; but one thing at least can be done which will cure the worst evils of the present situation within a week and without a dollar of expenditure. At the present time street car lines enter from the north, south, east and west, loop about through the crowded district on top of each other, so to speak, and then go out again as they came, thus occupying two streets in the crowded district for one in the outlying country, where there is room enough. When they do not do this, they mostly have a terminus in the crowded district, and thus obstruct its travel fully as much, if not more. One or two lines only take a straight course through the crowded district, from outskirt to outskirt.

All the lines, in our judgment, should do this latter, treating the heart of Boston only as a way station. By combining them in pairs this can easily be done, and with a considerable saving of car time and mileage and even greater public convenience. It would also have the immediate effect of reducing by something like a third the number of cars which at any one time are obstructing the crowded streets, while all sidewalk obstruction to reach any one point as a terminus would also be avoided. This last is, in itself, a very important consideration. When the lines were first built, each by an independent company, it was natural enough to "stub-end" them into or on the edge of the crowded district, and rest content with that. Under present conditions, the course suggested seems far more advantageous to all concerned.

This, in itself, is only a partial remedy, but the permanent remedy is equally simple and quite inexpensive. It is, as we see it, to subway both Tremont St. and Washington St., from curb to curb, through all the more crowded district (not over one-half mile long), extending the subways from time to time as the crowded district enlarges. The conditions for such subways are all remarkably favorable in five respects, which were all quite unfavorable in New York: (1) There are no sewers or water pipes of a size to offer serious difficulty in either street; (2) there is no danger of any trouble from water; (3) there is no quicksandy or otherwise treacherous or unstable material at any point; (4) there are very few high or heavy buildings on either route; (5) there are no vaults extending beyond the curb line, on Tremont St. at least, which is the line most urgently needed.

Under these conditions the subways can easily be built, in the best manner and lined with glazed brick, for $2,000,000 per mile or thereabouts; while a subway half a mile long on Tremont St. alone, giving ample room for five tracks, will remedy all immediate troubles. At some future day a Washington St. subway and a half-mile tunnel under Beacon Hill to give access from the west, costing perhaps $300,000, would also be needed, and of course would be convenient even now.

The advantage of such a subway is not alone that it doubles the width of the street at vastly less expense than an equal surface widening, but even more that it segregates the traffic, putting the electric car service by itself and leaving the ordinary street traffic to itself, leaving perhaps a few street cars still to run upon the surface to serve better local convenience. The total depression need not be great; hardly more than 14 ft.; 12 ft. for the cars and 2 ft. for the iron and asphalt roof above it. The climb up and down stairs of this height is not burdensome; for elevated lines it has to be much higher, and for the proposed Common terminus nearly twice as high.

As compared with elevated lines, instead of greatly injuring two floors of the abutting buildings, it leaves those which exist uninjured, and adds a new and almost equally valuable ground floor below the old one. Landings (and practically a continuous sidewalk) can be secured at nominal cost from the self-interest of owners, by simply offering to construct a landing extending back to their house line if they give access to it by public stairways, but otherwise passing the building by with a solid wall at the curb line. No sane owner would accept the latter alternative, though all would probably claim compensation if it were proposed as part of the scheme to construct a continuous sidewalk with occasional stairways to the street.

The only apparent objections to such a scheme are: (1) That there are no direct precedents for such a subway, while there are many for elevated railways, and (2) that the public have a prejudice against subways. But granting that there are no precedents, what is the function of a wealthy and highly civilized city but to create precedents suited to its needs and conditions, instead of following unsuitable ones like sheep? But as a matter of fact, there is now a precedent for the probable conditions of such a subway in the sub-cellar lunching room of the Cafe Savarin, in this city, which is wholly below, and mostly under the street, wholly dependent on artificial light and ventilation, and yet one of the most attractive, expensive and crowded lunchrooms in town. As for the public dislike of subways, in so far as it is real and based on reason (which is not far), it is based upon the precedent of the London subway lines, which are discouraging to capitalists because they hardly pay, and offensive to the public because of bad air. But the air is bad only because steam locomotives are used in them, and they hardly pay only because they do not run where many of the public want to go. A similar construction used by electric motors only, and running under the heart of London, would be a gold mine to its owners and, if built as attractively as it might be at trifling cost, the most popular route of travel in the city. Such lines in London are now authorized and likely to be built, as already described in our columns.

THE REORGANIZATION OF THE CORPS OF CIVIL ENGINEERS IN THE NAVY.

In our issue of Dec. 8, 1892, we editorially referred to the reorganization of the civil engineering staff of the United States Navy, as recommended by Captain Farquhar, in his annual report as Chief of the Bureau of Yards and Docks, United States Navy Department. On March 1 a bill covering this reorganization, and elsewhere given in full, was introduced into Congress, and is now before a joint committee of the Senate and House which, during the coming summer, is to consider the whole subject of the personnel of the Navy. The purpose of this committee is to recommend to the next Congress what legislation is necessary to settle for all time the long existing differences and friction between the line and the staff of the United States Navy, and to settle these questions in the best interests of the Navy, and in accordance with the late radical changes in warships and their equipment.

We again heartily approve of the bill directly referring to the civil engineers, and trust that it will be promptly made a law by the next Congress. The increase in the number of engineers provided for is a very modest one when it is considered that these 20 officers are to have charge of the maintenance of public works, representing a first cost of about $60,000,000, in addition to designing and superintending the construction of the new works for which Congress is appropriating money each year. As more fully explained in our previous editorial, the present civil engineering staff proper would be immensely overworked did it attempt to perform any large part of the duties falling to its share; and, in fact, it cannot properly attend to them. Six civil engineers only are available for duty in the Bureau of Yards and Docks and the 11 yards and stations now established; and in addition to this regular duty there are many demands for their services in inspecting structural work being prepared for the yards at private establishments, upon boards requiring experts in civil engineering, and for the preparation of plans and the supervision of work called for by other bureaus of the Navy Department. So great is the present demand upon them that four important details are now vacant, or filled by officers not civil engineers, and demands for the temporary services of the corps in other directions have been necessarily refused. The present roster is thus evidently and absurdly small, in view of the importance of the service demanded, and it cannot be too soon increased, with great benefit to the government.

The present practice of eking out the official corps by the temporary employment of engineers taken from civil life is one to be roundly condemned. These civilians have no recognized standing in the Navy, and their services may be dispensed with at any time that work slackens or the pressing need for their services ceases. It is the same practice justly complained of by the civil engineers in the employ of the War Department, and is not conducive to the best interests of the department which employs them. Nor has the government of the United States any right in equity to ask an engineer to devote the best years of his life in gaining experience in a special field of practice, as in naval engineering, and then to shut in his face the door to promotion to the higher grades of the service. And yet this is, and will continue to be, the fate of temporary assistants, unless provision is at once made for properly and regularly recruiting this corps, and placing all of its officers on an equal and regular footing, as far as service and promotion are concerned. This civil employment, too, is subversive of discipline, for the civilians are not in a position to command the respect and authority of commissioned officers, and cannot properly represent such officers upon boards or in the absence of their official employers.

We also approve of the method proposed by the bill for selecting the junior members of the reorganized corps. It is practically the same plan followed in recruiting the Corps of Engineers of the United States Army, a plan which has produced a body of exceptionally able men, in every way well fitted to perform the duties imposed upon them. But, as West Point and Willett's Point combined provide an adequate civil engineering course, and the Naval Academy does not, the two cadets annually selected for their aptitude and preference for the profession of civil engineering, are to be further educated at the expense of the government in the best engineering school or schools of the United States. This practically means at least eight years of training in naval and in technical methods, and the young assistant civil engineer should find himself exceptionally well equipped to perform the duties of the lowest grade in the reorganized corps.

The pay is very modest in all the grades; but there is some compensation for this in the rank, authority and permanency of employment. The pay for the assistant civil engineer corresponds closely with that established by law for assistant and past assistant paymasters and surgeons, but is less than that for the lower grade of steam engineers, and much less than that for assistant naval constructors. The highest pay for a civil engineer in the Navy, under the old law, is $3,500 per annum, and the increase of this sum to $4,000 after 20 years' service is but a tardy act of justice to the civil engineer in the Navy employ.

The one thing the proposed bill for reorganization does not touch upon, however, is the selection of the official head of the civil engineering bureau which directly controls the technical work and methods of these civil engineers. We know we trench upon delicate grounds in bringing up this question; but the writer hereof, and one of the editors of this journal, can speak both as an ex-line officer of the Navy, and as a civil engineer, and his views are those of conviction and not of prejudice. Contrary to the practice in the kindred bureaus of steam engineering, medicine and provisions and clothing, the Bureau of Yards and Docks puts at its head a line officer of the Navy who from lack of special training is unable to direct intelligently his engineering subordinates or to supervise or pass judgment upon their work. The heads of the other bureaus mentioned are selected as experts in the peculiar duties of their office, and are made so by long years of personal service in the same line followed by the officials under their charge. It is only reasonable, therefore, to assume that the head of a bureau having in its charge public property worth many millions, and continually called upon to discuss and pass judgment upon questions of the highest scientific and technical interest, should be himself an expert in this special profession. Executive ability is doubtless necessary in the head of such an office; but the training of the engineer, quite as much as that of the line officer, tends to the full development of this special quality, and the technical knowledge coupled with it enables the engineer to exercise the multitudinous duties of his office with more promptness and certainty. The appointment of the ablest and most experienced engineer in the corps as the head of this Bureau of Yards and Docks really involves no question of line or staff; it is simply the best appointment for the public interests concerned.

The Brazos jetties, near Velasco, Texas, are nearly completed. These jetties were commenced about two years ago to provide a deep-water entrance to the Brazos River. The two jetties are 5,400 ft. long and 560 ft. apart, securing 20 ft. of water over the outer bar. The jetties are made of brush mattresses, loaded with stone and consolidated with concrete above. The mattress-work was constructed from four rows of piles for each jetty, each mattress being from 2 to 3 ft. thick and 250 ft. long, and firmly bound together by strips and galvanized wire-rope. The pier-heads will be made of heavy blocks of stone and concrete. The cost of the work to date is a little over $150,000, and the work is being done by the Brazos River Channel & Dock Co. Mr. Elmer L. Corthell is the Chief Engineer and Mr. George Y. Wisner is Resident Engineer.

LETTERS TO THE EDITOR.

HIGHWAY BRIDGE LETTINGS.

Sir: The comments brought out on the subject of highway bridge lettings, and the numerous remedies(?) suggested, make very interesting reading to any one who has spent any considerable time on the road as an agent for highway work. The bulk of some of the letters published on the subject seem to be devoted to criticising certain designs for this class of work. The designs in question no doubt merit criticism, but I think that it is becoming rather a chronic complaint with very many to criticise highway bridge designs in general, the apparent objection being because they are as a rule of light construction. Why should they not be light, when perhaps they are never called on to carry the maximum load for which they were proportioned? A railway span of same length would, of necessity, have heavy sections and would be required to carry the maximum load for which it is proportioned, perhaps a hundred times per day, and that at a high rate of speed.

I think it a misrepresentation to assert that bridge companies doing highway work are at the present time employing agents who "guess the sections" in making up strain-sheets. Very many of my acquaintance are fully competent to design work intelligently, and those who cannot are supplied from the engineers at the home or branch offices. "Skin" designs are generally, at the present time, available only at "private lettings," which, by the way, are becoming more and more popular, in the Eastern states at least.

At a letting when competition is open to all, there are generally enough shrewd, well informed agents to head off a competitor from taking work on a design which is "not up." A popular impression among engineers seems to be that so long as the truss members are of heavy section, the perfection of good design has been reached; but it very often happens that these same reformers will show details on their plans which betray an ignorance of good construction that would be inexcusable in a boy with six months' experience in making shop drawings for a bridge shop. As to reform in the system of letting highway work, I would mention as necessary the following conditions:

1. Educate the highway commissioners up to a moral standard, where they will be willing to discharge their duties as such for the fees they receive, and refuse tempting offers of "commissions" from bridge companies. The same moral education to be accorded engineers who are intrusted with letting contracts directly or indirectly; for, sad to relate, some of them have been known to make "deals" in their own interest on such occasions.

2. Procure a new breed of bridge agents who will work more for glory and raising the standard of work built than for the money they can make out of the business.

3. Educate bridge companies in the belief that combines are sinful, and that it is better business policy to have square competition and 5% profit than the pool interests with the other bidders and have 25% profit.

In conclusion, should a highway bridge contractor be especially assailed for combining with others in his line to get what he can out of the county treasury, when the contractors for jail cages, courthouses, country roads, and in fact for everything the county buys all do the same? As long as county affairs are intrusted to farmers, so long will the much abused taxpayer be robbed. The same farmers who would howl most loudly against the expense of employing an engineer of good repute to consult in regard to letting a $2,000 highway bridge will, in their utter ignorance of the value of such work, pay $5,000 for the same bridge, and chuckle with glee to think of the engineer's fee which, by their economy, has been saved. A farmer cannot distinguish between a county surveyor and a bridge engineer. To him the former seems fully qualified and much cheaper. The local physician is supposed to be an authority on all diseases from consumption to "sore eyes." The county surveyor styles himself an engineer—then why should not he be competent as an expert on bridges, water-works, sewerage, etc.?

Is it practicable to enlighten the farming element on all these points by "circulars," as a correspondent suggests, when the most of them do not venture in literary matters beyond the county weekly?

Who, also, will incur the expense of such missionary work; and when it is accomplished, and every farmer from Maine to Texas knows that he is helping to pay two prices for the iron bridges in his county, how then can he help himself? Only by refusing to buy, in case the bridge companies should choose to maintain their prices. If we were all informed by "circular" that we paid a "pool" on all the hats we bought, what would be our remedy?—go bareheaded?

Yours truly,
F. W. Wilson,
Bridge Department, N. Y. C. & H. R. R. R.
Grand Cen. Sta., New York.

New York, Feb. 21, 1893.

CONCERNING HIGHWAY BRIDGES.

Sir: I have read with interest your recent discussion of highway bridge matters and feel inclined to offer a few remarks on the subject, being one to which I have paid considerable attention.

It has been my experience that highway bridge builders would rather build good bridges than poor ones, and as a rule they do build as good a bridge as the price will warrant and their skill permits. An abnormal "skinning" down of sections is not common, though it occasionally happens that after the cost of the pool is taken out, or after a close competition in a "free fight," there is so little left for the bridge that the temptation is strong to make an extra heavy coat of paint do duty toward keeping up the required dimensions of the members.

I agree with you that the pooling system is the worst evil that afflicts the highway bridge business. It is an incubus that has grown to an unwieldy size, and has fastened itself on the business with a grip like Sinbad's old man of the sea. It has become so important a feature that more than one case could be cited where parties have invested in a few tools and started a bridge company with the sole intention of getting the greater part of their living from the pools on bridges which they do not build. I know that the largest builders would be heartily in favor of abolishing the entire system. An attempt was made in New York state two years ago to do away by legal enactment with this evil, and also that of "private contracts." At the instance of one of the largest builders of highway bridges a bill was introduced into the legislature providing that when any bridge work estimated to exceed $300 in cost was to be done by any town authority, sealed proposals should be advertised for in a specified way, and the contract, if awarded at all, should be given to one of the parties submitting such sealed proposals. The occasion was inopportune, and the bill died of inanition.

Another evil which afflicts the highway bridge business, and is fully as important, though less generally appreciated than that just mentioned, is the poor quality of metal which is very generally used for such bridges. Steel is used almost universally, and with slight or no precautions as to quality, mode of manufacture or shop manipulation. None of the bridge buyers, and not all of the builders, appreciate the risks run in using the vast amount of rank metal which goes into highway bridges. A simple erasure of the word "iron," and the substitution of "steel," is alone considered sufficient justification for running the unit stresses up from 12,000 lbs. to 15,000 lbs. or 16,000 lbs., and after having secured a contract by thus cutting down the weight of the bridge, the successful bidder too often goes around to find out where he can buy "steel" cheapest. Sometimes, not always, an ultimate strength and elastic limit are prescribed, but seldom anything more. The result is that about all the stuff rejected by more intelligent and more particular buyers (usually railway companies), and all the much greater amount that is altogether too rank to be even offered to them, goes into highway bridges. Anything is considered good enough for them so long as it is called steel. The builders have learned that this cheap stuff is a tender metal to work and handle, and they have to be pretty careful to keep it from snapping to pieces; but if they can only once get it into a bridge without breaking it, that is all that is required.

It is true that if an engineer attempts to make a detail plan for an ordinary bridge, especially if he is a "general" engineer, and not thoroughly posted on shop work, the resulting structure will often cost more than a bridge of equal strength designed by the builder. But this applies to pin-connected structures only. On riveted work there are no peculiarities of detail or construction pertaining to individual builders, to conform to which would require a change in the standard practice of others. And on such work the furnishing of a plan by the engineer represents a saving to the builder of just so much labor and expense. A bridge engineer, however, is of more use than merely to furnish plans. If he knows his business he can prevent pooling every time on any work of which he has charge. He can, if he knows how, so specify his material as to require the good and reject the bad; and if backed by his clients (it costs a little extra) he can guarantee that only such material is used without having to depend on the contractor's word for it. He can, finally, give assurance that his bridge is properly erected, and left in good order by the builders, and this is by no means a small matter. It is not uncommon to find serious errors made by the erectors, either through ignorance or carelessness. A short time ago I found a bridge, built about fifteen years since, where the lower chord eye-bars were misplaced, some of the heavy ones in a center panel being interchanged with some of the light ones near the end. It was a grossly careless mistake of which the contractor could hardly have been ignorant, but apparently he did not care, and no one else knew the difference.

I believe the best results will be attained, together with the greatest economy to the purchaser, by employing a bridge engineer on all highway work. Such an engineer should, if the work is riveted construction, furnish a full plan; and if pin-connected, a strain and section sheet, allowing the builder to make details subject to the engineer's approval; he should specify clearly the kind of workmanship and material wanted, and should see that it is furnished, and finally should give a formal acceptance of the bridge before final payment can be made.

It often happens that a body of well meaning but ignorant, officials, after advertising in the usual loose manner for bridge proposals, gets an overwhelming mass of plans, specifications and bids, which they know nothing about, and then, as the easiest way out of the slough into which they have gotten themselves, call in an engineer and unload the whole business on him. The digestion of so heterogeneous a mass is as distasteful as it is laborious, and on account of the time it takes is generally much more costly than if the engineer had been employed in the beginning, and had set up a single standard upon which all bids should be based.

The engineer for a public body is often obliged to award contracts to parties from whom he is morally certain that he cannot get the best results, simply because they are financially responsible, and are the lowest bidders. The successful bidder takes the job with every assurance that all the requirements will be faithfully complied with, and very likely he fully means to do what he promises, according to his lights. But there is as much difference between bridge builders as shoemakers, and what would be considered first class work in one establishment would not be tolerated in another. The engineer knows this, and he knows, too, that in awarding a contract to one party he cannot, even if the bidder does his very best, get as good work as from some one else, for all the engineers in the world cannot get better work from a shop than it knows how to do. If he were at liberty to select his bidders this might be avoided, but on a public work this cannot be done. The poorest work is turned out mainly by those builders whose mainstay is the pool, and if that can be abolished, many of the companies which turn out the worst work will have to close up, as their chief source of income will have vanished.

Chas. F. Stowell.

Albany, N. Y., Feb. 19, 1893.

HIGHWAY BRIDGE LETTINGS.

Sir: You have struck a rich lead in taking up the subject of the letting of highway bridge contracts. The discussion is full of interest and cannot fail to give good results when continued in the intelligent manner in which it has been begun. To illustrate the need for it:

About a year ago a well-to-do county contractor came to me to get up plans and estimates for a bridge in his county. As my client was a "local" man he had to be downed at all cost, notwithstanding that I was in the legitimate bridge business, and was in want of work. After putting their heads together, the "boys" came to the conclusion that the only way to down us was to back the next strongest competitor, and for that purpose to subscribe a purse among themselves (presumably about 10% of contract price). This enabled our rival to bid below cost, and secure our defeat, of course. Bret Harte refers somewhere to the peculiar ways of the heathen Chinee, but if he had been a bridge man he need not have gone outside his own profession to record the tricks of man.

K.

Chicago, Ill., Feb. 25, 1893.

A BOSTON WRINKLE IN LETTERING.

Sir: About five years ago I fell to thinking that the method of making heavy-bodied or gothic letters upon plans was susceptible of much improvement, and forthwith began a series of experiments with stylographic pens. I wrote to makers of stylographic pens and manufacturers of liquid drawing inks, who maintained the scheme to be impracticable. As, however, the philosophical method of placing much liquid upon a plain surface seemed to be through a tube rather than by continuously hacking at it with two sharp steel points, I placed the condemned ink in the impossible pen, and "stylographic one-stroke lettering" was born. While so far as I know, the wholesale application of it to plan lettering is original with me, yet I presume others have discovered it for themselves.

Ten engineers and draftsmen to whom I have shown the capabilities of this much maligned pen have used it exclusively for tracings for some time, and in this office scores of large and small plans have been titled and lettered with it. Various pens have been used, but I get the best results with the Cross pen and Higgins' ink. By having two pens with fine and coarse points one can get lines of sufficient body for the important names on a plan and light enough for the fine descriptive text, all of which can be made at one stroke, and as rapidly as one wishes with an absolute uniformity to the letters impossible by any other method in the same space of time. The pens work best upon the dull side of the cloth. I cannot deny that some patience is necessary at the start before

the true inwardness of the pen is mastered, but when the art is attained, it will be found the quickest and most satisfactory way of doing three-quarters of the plan lettering of an office, I submit, Mr. Editor, sample prints for your inspection.

Fred. V. Fuller,
Asst. Engr. Metropolitan Sewerage.

Boston, Mass., Feb. 2, 1893.

(The samples are extremely good, and evidently free-hand quick lettering. But we find that our own draftsmen, whose work appears before our readers every week and is generally done about twice the size to which it is photographically reduced, obtain the same effect by single-stroke lettering with ordinary steel pens with various qualities of points; and we think our correspondent can do the same thing if he tries, and gets the proper coarse pens. Still, it probably takes a little more skill to do it in this way than with a stylographic pen, though the difference can hardly be great. Any kind of free-hand lettering requires a certain considerable skill if it is to look well, and no appliance can greatly reduce this necessity.—Ed.)

HIGHEST TEST RECORDS OF GRANITE.

Sir: Responding to your request for granite tests, I send you herewith a record of tests of Fourche Mountain granite, made under the direction of Prof. John C. Branner, late State Geologist of this state (Arkansas), now Professor of Geology at Stanford University, California, whose eminence in his profession will not be questioned. The Fourche Mountain granite is quarried within a mile of the city limits of Little Rock.

It will be seen that the mean of the tests is 30,740 lbs., against 30,000 lbs. for the Connecticut granite mentioned in your issue of Jan. 12.

Respectfully yours, J. H. Haney.

Little Rock, Ark., Feb. 4, 1893.

(We reprint herewith the table sent by our correspondent giving the result of tests on the Arkansas granite. It will be noticed that the tests were not made on 2-in cubes; but the pressures obtained are reduced to correspond to those on cubes of that size by Gilmore's cubic parabola formula. The reason why 2-in. cubes were not used was that the testing machine had only 50,000 lbs. capacity. Professor Branner states that many important edifices in Little Rock have been built of the blue granite, and it has been extensively used in making Belgian paving blocks.—Ed.)

Tests of Saline and Pulaski County Granites by the Arkansas Geological Survey.

Description of specimen.	Area, sq. ins.	Crushing load—Actual lbs.	Crushing load—Per sq. in. lbs.	Crushing load—Reduced to correspond to pressure per sq. in. in 2-in. cubes. lbs.	Ratio of absorption, 1 to :—	Specific gravity at 60° F.
Light colored elaeolite syenite, slightly decomposed....	2.34	48,000	20,500	22,350	761	2.62
"Gray Granite," a very light-colored elaeolite syenite..	2.25	33,750	14,000	16,000	83	2.45
Brownish elaeolite porphyry, occurs in narrow dykes..	1.42	30,000	21,000	24,980	161	2.52
"Light Blue Granite" (syenite).....	1.64	47,000	28,700	33,280	...	...
" " " (somewhat darker).....	1.07	22,800	21,500	26,820	...	...
" " " (still darker).....	1.57	35,950	22,900	26,745	1,673	2.64
"Medium Blue Granite" (syenite).....	1.50	43,500	29,000	34,150	...	...
"Dark Blue Granite" (syenite porphyry).....	1.57	43,800	27,900	32,630	4,530	2.69
Mean of last five specimens. Average for "Blue Granite"	...	.....	26,000	30,740	....	...

CONCERNING STREET CROSSING-STONES.

Sir: Will you kindly give me an expression of your views as to the advisability of having flag crossings on streets paved with granite blocks, and the practice in the city of New York? I have held to the opinion that they were unnecessary, and that the promiscuous granting of flag crossings wherever demanded by parties imagining them conducive to the trade of their private places of business was inimical to good street paving.

Very truly yours,
W. T. Brooke.
City Engineer.

Norfolk, Va., March 4, 1893.

(If by flag crossing is meant a smooth stone of any kind, we would strongly advise against their use. Crossing stones should never be smooth or made of a stone that will wear smooth. Sandstone, though wearing somewhat rapidly, is one of the best materials for this purpose. But if granite is employed, the top surface should be hammer-dressed. No crossing stone should be more than 10 ins. wide; and if two rows are required, it is well to put one or more rows of paving blocks between them. We regret to say that the New York practice does not quite agree with these requirements. Granite, in comparatively narrow blocks, is generally used, and it soon wears smooth. They are very frequently renewed in much traveled streets. As any crossing-stone is more or less liable to cause horses to slip, they are in that sense a nuisance, and the fewer there are of them the better. —Ed.)

NOTES AND QUERIES.

The address of Edward W. Howe, formerly of Milwaukee, Wis., is wanted by W. T. Casgrain, Chamber of Commerce Building, Chicago, Ill.

An adjustable plumb-bob was inquired for in our issue of March 2, and Williams, Brown & Earle, of Philadelphia, Pa., write us that they are agents for this plumb-bob, the retail price of which is $3.

W. C. Lambert, 167 Pawtucket St., Lowell, Mass., asks where he can find details of design of three-hinged metal arches (trussed).

The details of the three-hinged arch trusses of the Machinery Hall and Manufactures Building, at the World's Columbian Exposition, have been given in our issues of June 30 and Sept. 1, 1892. The three-hinged arch trusses of the new Philadelphia & Reading R. R. station were given in our issue of Jan. 19, 1893.

LONG DISTANCE TRANSMISSION OF POWER BY ELECTRICITY.

Three papers on this subject were presented at the recent meeting of the National Electric Light Association. The authors were Messrs. Chas. S. Bradley, of the Fort Wayne Electric Co.; Louis Bell, of the General Electric Co., and L. B. Stillwell, of the Westinghouse Co. An abstract of the three papers follows:

Mr. Bradley said the chief result obtained by the Lauffen-Frankfort experimental plant was the proof that very high voltages could be used and the insulation could be maintained. In fact, the maintenance of the insulation was the least trouble in the operation of that plant. One of the greatest troubles was the interference with the telegraph, and the next greatest difficulty was the "static induction." Each wire being so long and exposing so much surface becomes a reservoir to hold electricity, and the generator must fill this reservoir at each impulse before it can deliver energy at the distant end. When the generator reverses the direction of current, as it does some 100 times per second in the alternating, this reservoir must be discharged and filled with electricity of the opposite sign. However, this operation consumes but little power; it is an ebb and flow, as it were. The trouble is that this idle current, swinging back and forth, occupies the generating apparatus, so much so that the fuses were sometimes blown at Lauffen with no load of consequence at the Frankfort end. This difficulty is increased in damp weather, and varies with the length of the line and the amount of power transmitted. However, the Lauffen-Frankfort transmission was much longer than will probably be put in practical use for some time to come, and for transmissions to any reasonable distance the multiphase alternating is the most pliable and adjustable system that has ever been conceived. A patent issued to Mr. Bradley, Oct. 2, 1888, covers some important features of the multiphase system.

Where very high voltage and very long distance are to be overcome the direct current system offers some important advantages, if the power can be delivered in compact form. The high voltage may be obtained by the use of several dynamos connected in series, so that each will have only the strain upon its insulation due to the voltage which it adds. Thus, ten 500-volt machines may be connected in series to give a 5,000-volt direct current. By mounting the machine on wooden platforms, their attendance may be made perfectly safe, as a man cannot receive the discharge unless he forms the connection to earth. An advantage of this system is that it is impossible for the high-tension transmission current to get into the low tension distribution mains.

Dr. Bell, in his paper, discussed the question, What system is best adapted to different kinds of transmission? If the distance of transmission is moderate, the ordinary direct current generator and motor may be used; but troubles with the commutator practically limit the voltage of direct current dynamos or motors to about 1,200 volts. Machines for a higher voltage have generally broken down in the experimental stage. Thus for long distance transmission, either direct current machines in series (as described in Mr. Bradley's paper above) or the alternating current must be used. The latter Dr. Bell considered the preferable method for general practice, as to operate motors in series successfully they should be practically coupled to the same shaft, and should run as nearly as may be under similar and uniform conditions.

The question whether a single phase or multiphase alternating current should be used depends largely on the work to be done. If the single phase motors can be conveniently started, they are fully competent to take care of the work, except where current is to be supplied for electric railway circuits. Here the sudden and violent variations in the load are liable to pull an alternating current motor out of phase, and it will stop. The multiphase motor can also be pulled out of phase, but not quite so readily, and it can be more readily started. But where railway currents are necessary, a device can be used which is better than either the single or multiphase motor. It is scarcely more complicated than an ordinary railway dynamo, and it will transmute a multiphase alternating current into a 500-volt direct current. (This is an invention of Mr. Bradley's referred to above). In a recent test, a 100-K-W. direct current transformer of this type showed an efficiency of over 95% at full load, stood sudden variations from no output up to full load and back again without even a wink at the brushes, and bore up under heavy overload without any difficulty.

The above applies chiefly to transmission plants where the power can all be utilized at one point at the receiving end of the line, as for example a central station manager may wish to displace his steam engines and boilers by motors operated by electric current, transmitted from a water-power generating station many miles away.

Mr. Stillwell's paper was a statement of the methods to be used in solving the following problem: "What are the total annual charges against a hydraulic plant and electrical installation utilizing cheap power at 'A' and transmitting it to 'B,' as compared with the annual charges against a steam and electric plant located at 'B' and capable of supplying the same amount of energy in equivalent form to the local distributing circuits?" He proposed the following as a formula for the solution:

Fb = First cost of real estate and buildings.
Pb = Percentage, covering interest upon and maintenance of real estate and buildings.
Cb = Constant expenses, taxes, insurance, etc., on real estate and buildings.
Fs = First cost of complete steam plant, including engines, boilers, steam pipes, pumps, heaters, etc., installed.
Ps = Percentage, covering interest upon and maintenance of steam plant.
A = Cost of fuel to produce one pound of steam.
S = Pounds of steam used per indicated horse power per hour.
N = Number of indicated horse-power-hours used per year.
Ws = Cost of water (if any) per annum.
Os = Cost of oil and waste per annum for steam plant.
Fe = Cost of electric generating plant, including exciters, regulators and complete station equipment.
Pe = Percentage, covering interest upon and maintenance of electric generating plant.
Oe = Cost of oil and waste per annum for electric plant.
Cse = Constant expenses, including superintendence, wages, taxes, insurance, steam, etc., steam and electric plant.
Then .. PbFb + Cb + PsFs + ASN + Ws + PeFe + Os + Cse + Oe = annual charges on steam and electric plant.
For the hydraulic and electric plant we have the following:
Fb = First cost of real estate and buildings.
Pb = Percentage, covering interest upon and maintenance of real estate and buildings.
Cb = Constant expenses, taxes, insurance, etc., on real estate and buildings.
Fh = First cost of hydraulic plant, including turbines, dams, flumes, etc.
Ph = Percentage, covering interest upon and maintenance of hydraulic plant.
Oh = Cost of oil and waste per annum for hydraulic plant.
Ch = Constant expenses, including superintendence, wages, taxes and insurance on hydraulic plant.

A = Cost of water per horse-power-hour (where water rate is paid).
N = Number of horse-power-hours at turbine used per year.
Fe = First cost of electric apparatus between turbine and local distributing circuits exclusive of line.
Pe = Percentage, covering interest upon and maintenance of electric plant exclusive of line.
Oe = Cost of oil and waste per electric horse power from generators for electric plant.
Ce = Constant expenses, including superintendence, wages, taxes, insurance, etc., on electric plant.
Fl = First cost of pole line, insulators and conductors.
Pl = Percentage, covering interest upon and maintenance of pole line, insulators and conductors.
Cl = Constant line expenses (supervision and repairs).
Then : PbFb + Cb + PhFh + Oh + Ch + AN + PeFe + Oe + Ce + PlFl + Cl = annual charges on hydraulic and electric transmission and conversion plant.

In the discussion on these papers, Mr. W. J. Hammer, criticising Dr. Bell's statement that 1,200 volts was about the practical limit of potential with direct-current machines, said that Professor Crocker was now running direct-current machines of 5,000 to 6,000 volts without any difficulty. Dr. Bell, in reply, said that this might do on small machines, but a man who thinks that he can build a 5,000 or 6,000-volt machine for large currents had better do it before bragging about it. By large machines he did not mean machines of 50 to 70 HP. merely, but machines of great power, suitable for transmission of large amounts of energy over long distances. Professor Weston, however, replied that there was no difficulty in operating direct-current machines at 5,000 volts with an output of several hundred amperes.

Mr. L. B. Stillwell said that one reason why long distance transmission apparatus had not been largely developed commercially was that the electric lighting and electric railway apparatus had thus far kept the electrical shops fully employed. Within a year or two, however, a great deal more has been done in long distance work.

As to the relative merits of the two-phase and three-phase systems, the first requires two transformers at every point where the three-phase requires three transformers. This, to a practical man, is sufficient to outweigh all claim of superiority made for the three-phase motor, supposing them all to be true.

In reply to the question why alternating current motors of small power to run on an ordinary circuit were not on the market, Mr. C. S. Bradley said he had tried to build such motors, and had succeeded in building a motor of 1 to 2 HP. which had an efficiency of 52%. He had not been able to dispense with the commutator, and when a commutator was used the sparking was something dreadful. If it was not bad when the motor was first started it would become so in a few hours, and no brush that was tried could overcome the difficulty. Dr. Bell said that Mr. Brown, of the Oerlikon Co., had apparently overcome the trouble from sparking in the motor which he had developed, but as yet his motors do not start well. Small fan motors run well enough on the ordinary alternating current, because a very slight torque is sufficient to start them. Professor Forbes said that in Europe both the two-phase and the three-phase motors are working very satisfactorily. As for the alternating motor for ordinary circuits, one can hardly go into an electrical workshop in any country where the head man is possessed of originality and is a thinker as well as a mechanic, without seeing some work in progress on an alternating current motor of a single phase. He had seen at least a dozen classes of such motors, all working fairly well, but none of them are on the market yet.

President Ayer, in closing the discussion, said it had demonstrated a fact of much importance to central station managers, that the simple alternating current motor, to run on an ordinary circuit, which has been so long and so anxiously looked for, is not yet in existence, and the outlook for its appearance is not encouraging.

The next case to be considered is where transmission is combined with distribution. Here the triphase direct current transformer just described can be used to feed railway circuits and also direct-current incandescent lighting plants on either the two-wire or three-wire system. Any existing alternating current incandescent circuits can be fed from the distant point by banks of transformers. If any new centers of distribution are to be made with circuits independent of those already in existence, these can be operated very effectively for both lighting and motor service by multiphase apparatus. It has been asserted that incandescent lighting cannot be successfully done on a multiphase circuit; but this is an absolute mistake. There is no trouble at all in doing it if the wiring is properly done.

A multiphase motor should have very nearly the properties of a good direct-current shunt motor, and not far from the same efficiency. It has the advantage over a shunt motor of having no commutator, and no necessity for any moving contacts, and of running at nearly constant speed independent both of load and of moderate variations in voltage. It is, on the whole, less thin-skinned than a shunt motor, and will stand very severe usage in the shape of overload without a burn-out. The efficiency is within a per cent. or two of ordinary shunt motors.

As to the relative merits of the two-phase and three-phase systems, the difference is not great, but what advantage there is lies with the three-phase. It has been said that multiphase motors take an enormous current when running light, and that they introduce a large and objectionable lag on the line. These faults, when they occur, are due to bad design. A good multiphase motor will take somewhat more current when running light than a direct-current motor, but it takes very little more energy, as the lag makes the apparaent current greater than the real. As motors are usually stopped when power is not wanted, the current consumed when running light is not of much importance anyway.

There is a possibility that we may have before long motors which will run successfully on an ordinary alternating current circuit, constructed after the methods proposed by Elihu Thomson a few years ago. They are already practicable in very small sizes. Brown, of the Oerlikon Co., has been making a great effort to exploit motors designed on these principles abroad, and has obtained motors which run successfully, but as yet do not start well under load.

The question of using high-tension dynamos, or step-up and step-down transformers, is one affecting many long-distance transmission schemes. An alternating dynamo of 4,000 or 5,000 volts is considerably more expensive and less reliable than one wound for 1,000 or 2,000 volts. As a rough rule, it may be said that at ordinary prices of apparatus and copper, the two methods become of equal cost when the distance of transmission is seven to eight miles. Above this distance the transformers will cheapen the plant; below it they will make it more expensive.

The allowable drop in the line is merely a question of relative cost of copper and of apparatus, so far as the first cost is concerned. If apparatus is cheap use larger generators and allow more drop in the line. If copper is cheap and apparatus is dear, use more copper in the line and smaller machines. A drop of 15 to 20% is about right in most cases. These statements are made up as the result of the investigation of a large number of actual transmission schemes which have been examined in detail and for some of which the apparatus is now under way. They may therefore be relied on.

The final question is, At what distance is long distance transmission commercially feasible? After an examination of the profit and loss possibilities of a large number of plants of all descriptions, the author felt safe in saying that power transmission to a central station would, unless the cost of the development of the water power was exceptionally great, almost universally pay at distances of 10 or 12 miles. It will frequently pay up to 20 or 25 miles. Now and then, under extraordinary conditions (very expensive coal or very cheap water power) it will pay up to 40 or possibly even 50 miles. The author had never personally investigated a proposed transmission over 50 miles that gave any promise whatever of financial success, but the time may come when such a case will appear; and if it does, the electrical part of the enterprise can be successfully carried through. The greatest difficulty in operating over long distances is the difficulty of keeping a long line in proper repair. Eternal vigilance is the price of success in this respect. Otherwise there is little trouble.

The administration of the State Railways of France has placed orders for 50,000 mild steel ties.

NOTES FROM THE ENGINEERING SCHOOLS.

The report of Prof. N. S. Shaler, Dean of the Lawrence Scientific School, states, as showing the rapid growth of the school, that in 1887 only 14 students were registered; in the present year there are 181. The increase is ascribed largely to the fact that the school offers the unusual advantage of combining a measure of academic culture with a thorough training in some branch of science; and moreover, that special effort is made to adapt instruction to the individual student, and to place him in a situation, at the end of the course, adapted to his capabilities. Within the last year eight new scholarships have been established, which are of particular value, as they can be assigned to students immediately upon entering, and thus reduce, for needy students, a technical education to the least possible cost. To the list of courses there has been added one on physical training, aiming to provide a training for those who intend to study medicine, to fit men to take charge of gymnasiums and to afford systematic instruction in exercise and hygiene to students who may need special care of their health. A laboratory for the course in physical training has also been established, and a grant of $1,000 made to fit it up with apparatus.

Prof. Mansfield Merriman, of Lehigh University, wrote us as follows some weeks since as to the hours of work per week at that university:

My attention has been called to the fact that you credit Lehigh with 15.8 hours per week in your statement of students' work. This is the number of class exercises per week, and the hours are materially greater, one exercise being one hour in length if a lecture or recitation, two hours in length if drawing, and three hours in length if field or laboratory work. For our civil engineering course I find the number of hours per week spent by a student in class exercises averages very closely 22—being about 18 during the first year, 22 during the second, 25 during the third and 23 during the fourth. As to the hours spent by students in preparing for these class exercises, or in writing theses, I can give no information.

Professor Merriman kindly adds: "This letter is not for publication, as I do not wish to be put in a position of criticising or complaining of any statements you have made. The work has cost you much labor, I know, and errors now and then are unavoidable." It is a fact that they are so, or rather were so, which is the very reason why we are always glad of an opportunity to correct them.

Union College, Schenectady, N. Y., one of the very oldest of our engineering schools (founded in 1845), is almost alone among them in the extent to which its engineering school is incorporated with the classical or academic department as one compound whole; a fact the more peculiar because it has four other distinct professional schools. If general practice is any criterion, this must be unfortunate for the school, and it is a fact that its engineering department has not grown so fast as many others. Experience has surely proven this, that the successful management of a school of engineering and of a classical college calls for very different acquirements, and to a large extent, a different type of man.

Prof. F. R. Hatton, of Columbia College, writes to us as follows in regard to certain errors in the tabular statement forming part of our discussion of technical education in our issue of Dec. 1 and in the diagram of Jan. 12, and especially in regard to allowing for the required vacation work at Columbia, on which his position is perfectly just, the only trouble being that in our original report the facts as to this required work were not made so clear:

1. In the tabular statement of Dec. 1, the total should be 4,720 instead of 4,201, for Columbia College for the course in civil engineering, and 5,140 for mining engineering. This discrepancy, of course, will make a difference in the total as plotted graphically in your issue of Jan. 12, and I inclose you a slip on which items making up this total can be separately observed.

2. The method of arriving at the results indicated by the figures given in your Table XXXIV. of Dec. 1, if I understand it correctly, is likely to give a result unfair to us at Columbia, as well as to certain institutions other than Columbia, in which latter, of course, my interest particularly lies.

The reason for this inaccuracy in the case of Columbia arises from the fact that while correctly stated the

term covers 32 weeks or 128 for the four years, this takes no account of the arduous and exacting summer schools which form a part of the regular curriculum exacted of engineering students and bring up the number of hours in surveying and advanced technical specialities to a much higher figure.

In the case of Columbia, on this basis, it would be made to appear when 4,720 hours is divided by128 weeks. The mean number of hours per week then rises to 37, the effect of which, of course, will be to raise the proportion of time devoted to most of the studies at Columbia and particularly the surveying. It will very materially diminish the blank space at the top to make this correction.

3. In the table and the resulting diagram, the most serious error in quantity is in the relative dimensions of the space allotted to surveying and chemistry for engineers. Chemistry is much too large and surveying about as much too small. These errors can be corrected from the tabular statement which I inclose to you.

4. I fail to notice in your statement (of Jan. 12) of some of the reasons inducing a short term as compared with a long vacation, allusion to a fact which presses severely upon the institutions having a metropolitan location, although you obviously have not failed to have it very near the surface in your discussion of consideration lettered "C."

In the colleges having no regular dormitory or mess system, but where the students have to lodge and board themselves, under metropolitan conditions, there is a strong inducement to make the term time of compelled attendance at the college and compelled residence under these circumstances as short as possible in order to diminish the cost of his education to the man who does not live at home. This is a matter of moment in New York, and has always an influence in discussions which look toward the lengthening of the regular term. It is the experience, moreover, of those who have been in charge of instruction in institutions where the number of hours per week is kept high that the standard of class-room performance will drop during the intemperate heats which prevail in September and June in many of the cities. More real and earnest work is done in a short term of cool and bracing seasons of more hours per week than in a longer term of fewer hours per week under less favorable conditions.

The force of this argument in respect to the proper duration of class room work is undoubted. It only becomes fallacious when pushed to the extreme of assuming that it applies equally well to all the different kinds of required work which are done, or might be done, or should be done, in a good engineering school. We shall give later the tabular information referred to in this letter.

The Sheffield Scientific School, of Yale, stands in great danger of losing the Agricultural College Land Grant fund, from which it has derived an average income for the past 30 years of nearly $9,000 per year, the present rate, we believe, being somewhat over $20,000 per year. It is alleged that only 13 students in all have been graduated in agriculture since 1862, that there is not now, and has not been for three years, a student of agriculture at the school, and yet that there are 80 students receiving state scholarships at an average rate of $200 each per year. It is therefore proposed to transfer this fund to Storr's Agricultural College, that the farmers' sons may receive the benefit of the grant, according to the intention of the grant. There can be no real doubt that that was the intention of the grant, and that Yale is hardly calculated to fulfil that intention; and yet, the subdivision of educational funds among many small colleges is certainly not calculated to secure the greatest good from these grants.

BRIDGE BUILDING OPINION—A BIT OF HISTORY.

It is a recognized fact that the impossibilities of one generation are often the commonplaces of the next, but it is not generally recognized how often some proposition for an advance in practice, which ought to have considerate attention at least, meets with bitter opposition, and the bitterest of all from those who might be supposed to be best qualified to judge of its merits. A curious and all but forgotten instance of this kind is recorded in Prof. C. M. Woodward's "History of the St. Louis Bridge," and is worth reviving from oblivion for the lesson which it teaches.

In the beginning of that project two rival companies were in the field, the Boomer company and the Eads company. The story of the early rivalry between these companies, and of the convention of engineers by which Mr. Boomer sought to break down the Eads scheme, is thus told by Professor Woodward:

Meanwhile the rival company was in the field. As soon as it was certain that his charter would be granted, Mr. Boomer and nine other persons, all residents of Illinois, organized a company in Missouri, under "An Act Concerning Private Corporations," on Feb. 10, 1867. The name was declared to be "The Illinois & St. Louis Bridge Co.," "and under that name and style (it) shall continue to exist for the term of 100 years." Messrs. L. B. Boomer, R. P. Tansey, W. R. Morrison, Geo. Judd and C. Beckwith were named as directors to manage the affairs of the company for the first year. The capital stock was fixed at $1,000,000.

. . . . . .

It is but just to all parties for the writer to record here, after a very full and impartial examination of all the facts that he is of the opinion that Mr. Boomer and his associates were at this time entirely sincere in their expressed intention to build a bridge at St. Louis, and according to the terms of their charter. With full legal authority on the Missouri shore, and an exclusive charter in Illinois, what rival or what opposition could he find? With the approval of his charter it was expected that all faith in the "defunct Cutter charter," as the charter of the St. Louis & Illinois Co. was called, would be lost, and Mr. Boomer was doubtless very much surprised to find that Mr. Eads, instead of abandoning the field, pushed on with renewed energy to get his plans before the public and to secure the co-operation of capitalists. Where Mr. Boomer expected to have things all his own way he found himself opposed by one who possessed to an uncommon degree the confidence of his fellow citizens, and who united to the skill of an engineer great executive power and unusual resources as a financier. With dismay Mr. Boomer saw capitalists, both at home and from New York, coming to the support of the St. Louis company, while he and his entire enterprise were popularly regarded with distrust. . . . . .

The strong determination on the part of the St. Louis men to build and control their own bridge, and an obvious firm reliance on the validity of their charters, left Mr. Boomer only the alternatives of driving the other company from the field or of withdrawing himself. Two bridges were clearly out of the question. Of the two courses open to Mr. Boomer, he chose the former; he resolved to break down the St. Louis company.

Three methods of breaking down his opponents offered themselves to Mr. Boomer. The first was to bring discredit upon their plans while recommending his own. This was to be done through the instrumentality of a convention of engineers.

Preparations were accordingly made, and elaborate reports were prepared. At least nine different engineers of reputation were set to work by Mr. Boomer upon the various problems involved, while especial prominence was given to the question of a 500-ft. span for the bridge. The convention called by Mr. Boomer met at St. Louis on Aug. 21, 1867. The following is a complete list of the engineers invited to be present (according to what appeared to be an official list given in the St. Louis papers): W. J. McAlpine, C. L. McAlpine, Gen. W. S. Smith, Geo. A. Parker, E. S. Chesbrough, W. S. Merrill, R. B. Mason, T. B. Blackstone, L. H. Clark, E. H. Johnson, S. S. Post, S. F. Johnson, T. McKissock, J. B. Moulton, O. Chanute, Jas. H. Morley, A. Anderson, T. J. Homer.

On motion of Colonel Anderson, Mr. Boomer's chief engineer, Wm. J. McAlpine, who had been engaged at the request of Mr. Boomer upon the subject of the foundations, was chosen president. In the appointment of the committees it was natural that Mr. Post should be the chairman of the "Committee on Superstructure and Approaches," and that the entire "Committee on Foundations and Piers" should be composed of Mr. Boomer's employees.

The convention contained much ability, and the contributions of several of the engineers were worthy of their authors; but there was a common theme upon which every set of resolutions was most emphatic, namely, a disapproval of a 500-ft. span, either on the ground of safety, or economy, or "authority." This, the main point of the convention, is best shown by a few quotations from their resolutions and reports:

Resolved, That we as practical engineers cannot conscientiously recommend to the parties in interest to venture upon the construction of spans of as great length as the maximum one prescribed by law (500 ft.). . . . . .

Resolved, That in view of all the circumstances of this case, we would recommend spans of less than 350 ft. in the clear, if the federal law permitted such reduction.—Committee on Foundations and Piers.

The "Joint Committee on Foundations and Superstructure" expressed by resolution "their unqualified disapprobation of spans of 500 ft.":

The Joint Committee on the Regimen of the River, on the Foundations and Piers, and on the Superstructure discussed the alternative proviso of the law in regard to the length of the spans across the main channel, and unanimously agreed that it was inadvisable to adopt the span of 500 ft. clear opening, on account of the difficulty of procuring suitable materials of the proper form, size and workmanship required to meet the extraordinary strains to which some of the members of the truss would be subjected; the increased hazard of its construction and maintenance; the large additional cost of the whole structure by the use of the long span; and because the necessities of this case do not require the use of one of such great length, for which there is no engineering precedent.—General Report, p. 79.

When the report had been properly revised to suit Mr. Boomer's plans it was:

Resolved, That all the members present (there were very few left) be requested to sign the same (the General Report) before its publication, and that a copy be sent to each member not present, with the request that he shall affix his name thereto and return to the president at St. Louis.—By the Convention, Aug. 31, 1867.

In consequence of this last resolution, the report, as printed, is signed by 28 gentlemen, all engineers, about one-half of whom took no active part in the convention.*

* "The convention, including the services of engineers engaged by Mr. Boomer to prepare and submit reports, cost Mr. Boomer upward of $60,000."

"A very just and able review of portions of the report of the convention will be found in Mr. Eads' first engineering report, May, 1868. Though appreciating and admiring the dignified courtesy and charity with which he endeavors to shield his professional brethren from the charge of permitting themselves to be used for a discreditable purpose, the writer of this history does not feel that the courtesy and charity was in all cases deserved."

This convention fell quite flat upon the community of St. Louis. It object was so well understood and so little sympathized in that no one was deceived. It is even probable that such ex-parte proceedings made friends for the St. Louis company. Work on the west abutment was begun the very day the convention met, and, in spite of difficulties of all sorts, the work was continued through the autumn and winter without break. Stockholders of the St. Louis company continued to pay their monthly assessments and new stockholders were added. About Sept. 30, Mr. Eads' plans were shown in drawings exhibited on 'change, and compared with those of Mr. Post. The stability of his piers, which were to have no other foundation than the solid bedrock below the river, the wide and lofty spans, the beautiful proportions of the bridge, and the open view commanded by its spacious highway, did not fail to arouse the admiration of all.

Thus this grand move of Mr. Boomer failed, but it narrowly missed success. Had there been less courage, less indomitable energy, less engineering ability in the St. Louis company, it would have surrendered. As it was, its operations were seriously embarrassed. A feeling of distrust and uncertainty was created, especially away from home, which, when the real difficulties of the undertaking came to be better understood, rendered its progress extremely slow and costly. It is not easy to say what "might have been," but it is strictly within reasonable limits to say that the measures of Mr. Boomer cost the bridge company hundreds of thousands of dollars, and delayed the erection of the bridge more than a year.

The list of names given above includes a large proportion of the more prominent bridge engineers of that early day. It is not surprising that many or most of these gentlemen should have felt doubts of the expediency of so long a span; but that so many of them should have been willing to lend themselves to a movement actively to crush the proposition, and should have advanced as their clinching argument that there was "no engineering precedent" for it, augurs a strong sense that the effort would be likely to fail, for it is inconceivable that so many prominent men would have lent themselves to such a movement merely to earn a fee, or unless most of them had convinced themselves that the effort was so hazardous as to be technically indefensible. But if engineers were to oppose habitually plans for which there was "no engineering precedent," what would become of engineering progress?

We can now see that there were no unusually serious hazards of any kind in the construction of this bridge. All very large enterprises "for which there are no engineering precedents" involve hazards of partial failure, but the only fair or defensible grounds for professionally opposing them are, first, that the proposed details of construction have not been sufficiently specified, or secondly, that such and such of these details are, for specific reasons stated, impracticable or doubtful, and if doubtful will involve serious consequences if changed during the progress of the work.

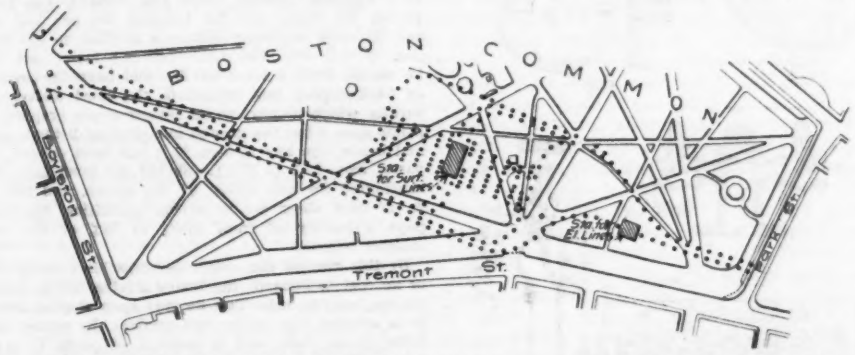
Mr. Gunwald Aus, with the Phoenixville Bridge Co., calls attention to the fact that the Kragh-Jorgensen magazine rifle, lately approved by the Board of Officers of the U. S. Army, is Norwegian in its origin, and not Danish or Swedish, as stated in our issue of Feb. 23. Mr. Aus says that Mr. Kragh is the director of the Norwegian rifle factory, at Kongsberg, Norway, and Mr. Jorgenson is a Norwegian and one of Mr. Kragh's assistants. We are pleased to make this correction.

THE PROPOSED STREET RAILWAY TUNNEL UNDER BOSTON COMMON.

The accompanying map, reduced from one prepared by the West End Railway Co., shows in plan a pending scheme for a street car tunnel and terminus under Boston Common, which has been lately proposed by that company, and which is discussed on our editorial page. The scheme in brief is to construct three nearly parallel double-track tunnels, each of which is lighted and ventilated every 30 ft. by a short shaft 6 ft. in diameter, surrounded by a railing on the surface. The idea seems to be modeled in this respect on the old Harlem Railroad tunnel on Fourth Ave., in this city, which was fitted for street car use by cutting similar apertures in its roof; but, although strenuous efforts are made to keep this clean, those who have occasion to use it often know how ineffectual the openings are as a scheme for ventilation, since the odors which naturally follow after horses are always noticeable in it. If the change of air were reasonably quick this would not be.

Another part of the Boston Common scheme is to construct a large subterranean street car terminus extending back from about the middle of the Tremont St. front nearly to the Frog-pond and old elm, as outlined on the maps by the large rectangle of dots, which show the proposed openings for light and ventilation. In all, some four acres would be occupied by this terminus, though not all of that area would be excavated.

At this terminus the scheme was (and possibly still is) to collect the cars for a large number of



MAP SHOWING PROPOSED STREET RAILWAY TUNNEL UNDER BOSTON COMMON.

the street car lines radiating from the "congested district" in all directions, if not all of the street cars entering the city. Consequently all passengers who wanted to take any one of these lines would first have to walk to this point, and then down nearly 30 ft. of steps, according to a vertical section which we do not engrave.

The whole work was, or is, proposed to be done by excavation from the surface, which, with the necessary side slopes, would imply an excavation nearly 100 ft. wide, and much more in the aggregate at the terminus. This would necessarily mean the destruction of all the old trees within the excavation lines, of which there are many, some of them centuries old. This fact, and the permanent defacement of the Common by the pepper-pot "breathing holes," and the proposed addition of two large buildings for stations, have created an intense feeling of opposition among the citizens, who justly claim that the historic interest of the spot alone should protect it from such defilement.

Fortunately, the project involves serious practical disadvantages, both to the public and the great street railway company which proposes the scheme, and now controls all the street car lines entering or in Boston. In their excitement over the "sentimental" issue these practical objections, and the much better and cheaper alternative which they can adopt if they choose, seem to have escaped attention among those most interested. We have done our best to point them out elsewhere; and have little doubt that the scheme shown on the accompanying map, at least, will never be carried out.

LOCOMOTIVE TESTS IN HEAVY EXPRESS SERVICE.

Some very interesting tests were made last summer on the C., B. & Q. R. R. of the comparative efficiency of several types of locomotives for handling heavy express trains on long runs at high speed. The results of these tests have just been reported by Mr. Wm. Forsyth, Mechanical Engineer of the C., B. & Q. R. R., in a paper before the Western Railway Club. The paper is too lengthy for reproduction in full in our columns, but those of our readers who are interested can obtain copies on application to the secretary, Mr. C. F. Street, Rookery Building, Chicago.

The net results of the tests were that the Vauclain compound locomotive showed a coal consumption of 25% to 38% in excess of the ordinary C., B. & Q. locomotives of the same class, and its record was poorer in almost every respect when running at the average rate of 45 miles per hour. At 30 miles per hour, on the other hand, the Vauclain compound showed considerably better results than the simple engines.

A comparison between the efficiency of simple locomotives with 62-in. and 68-in. drivers showed that with a train of ten cars or less the 68-in. driver engine used steam most economically. With longer trains the 62-in. driver engine showed the better record of the two.

A two-cylinder compound locomotive with 62-in. drivers, built in the C., B. & Q. shops for fast freight service, was also tested; but it was afterward found that the engine had a cracked port plate, permitting leakage of steam from the high-pressure to the low-pressure cylinder, and the results were therefore thrown out. The engine has never shown, however, a record in passenger service equal to that of the company's regular passenger engines. The accompanying table shows the general results credited to each engine as an average of all its trips.

The following are the "general conclusions" as expressed by Mr. Forsyth:

1. The coal measurements show 22% more tons of cars hauled per lb. of coal by the simple "H." engines than by the Baldwin compound.

2. The average rate of evaporation was 5% more with the simple "H." engines than with the Baldwin compound.

3. The cylinder performance measured by the indicator cards taken at average running speed, 45 miles per hour, shows 18% more foot-pounds of work done per heat unit in the steam used by the simple engines than by the Baldwin compound.

4. At 30 miles per hour the cards show the Baldwin engine to have the best economy, developing 14% more work per heat unit than the "H." simple engines.

5. The poor showing made by the Baldwin compound was largely due to the heavy train and high speed. With a lighter train, or the same train on a slower schedule, it would have shown a much better economy. The cards taken at 30 miles per hour showed this.

6. The Baldwin compound engine, as operated on the C., B. & Q. R. R., on trains 1 and 6, weighing 350 to 400 tons, was not as economical in the use of coal as the C., B. & Q. simple "H." engines, by about 25%.

7. When worked in heavy express service the Baldwin compound, 82, lost the principal advantages of compounding, namely:

(a) High initial pressure in the cylinders; (b), increased number of expansions; (c), softer blast on fire.

As a result its boiler performance and cylinder performance were not as good as simple engines of proper capacity.

The question why the Baldwin compound showed such poor results is further answered as follows by Mr. Forsyth:

The Baldwin engine had: 17 lbs., or 11%, higher boiler pressure; 41% more heating surface; 20% greater weight of engine and tender; 6 ins. greater diameter of boiler; 4 ins. larger drivers; 8½ lbs. less average steam pressure at cut-off. The measured weight of coal and water shows that the Baldwin engine used 25% to 38% more coal, and 13% to 22% more water per dynamometer horse power, than any of the simple engines tested, and we must conclude that this is largely due to the uneconomical use of steam in the Baldwin compound cylinders. We account for it in part by the fact that the average cut-off was 15 ins. or ⅝ stroke in the h. p. cylinder. The card shows that at speeds as high as 50 miles an hour this long cut-off was maintained, and as a consequence steam had to be throttled from 177 lbs., down to from 120 lbs. to 145 lbs. The average steam line of 12 cards, from engine 82, taken at speeds of 45 to 50 miles an hour was 129 lbs.—a drop of 48 lbs. below the 177 lbs. available in the boiler—a loss of 27% in pressure to cylinder. The average steam line of 8 cards from "H" engine No. 145, at the same speed, shows a pressure of 137½ lbs., or a drop of 22½ lbs. from the average boiler pressure of 160 lbs., or 14%; about one-half that of the Baldwin. The average steam pressure up to cut-off was 8½ lbs. greater in the simple engine.

With an average cut-off of ⅝ stroke, and ratio of cylinders 1 to 3, the Baldwin compound did most of its work with 4 to 8 expansions. The simple engines when running at speed, cut-off at 4 ins. and 5 ins., and the steam had 5 to 6 expansions. The simple engines, therefore, had the advantage of higher pressure up to point of cut-off, and a higher rate of expansion, the two most important qualities which a compound engine must possess in order to produce a superior economy.

In one of the cards taken from the Baldwin compound, the weight of steam in the h. p. cylinder, at 15 ins. cut-off, was 0.4233 lbs., and in the l. p. cylinder at 18 ins. cut-off, just after valve closure, it was 0.4751 lbs., a difference of 12.2%.

Some of the cards on which the expansion line was drawn showed some leakage through the valve to the h. p. piston, and a considerable admission of live steam to the l. p. cylinder, through piston valve and the starting valve while running at 45 miles per hour. On one of the cards this extra admission was found to be 15% of that admitted to the h. p. cylinder at the point of cut-off.

The ash-pans and smoke-boxes were not cleaned during the trips, and for a time the ashes and sparks were weighed. The Baldwin engine threw more sparks and wasted more coal through the stack than either the simple or compound "H." engines. The amount of ashes in pan at end of trips amounted to 7% of the coal used. The cinders in smoke-box of Baldwin compound at end of trips weighed 700 to 900 lbs., or an average of 5.7% of the coal used. With the C., B. & Q. compound, only 200 to 300 lbs. of cinders were found in the smoke-box at the end of the trip, or 2.2% of the coal used. I conclude from this that the effect of the exhaust on the fire is much more favorable in a 2-cylinder compound than in a 4-cylinder. The rate of evaporation in the C., B. & Q. compound was 10% better than the Baldwin.

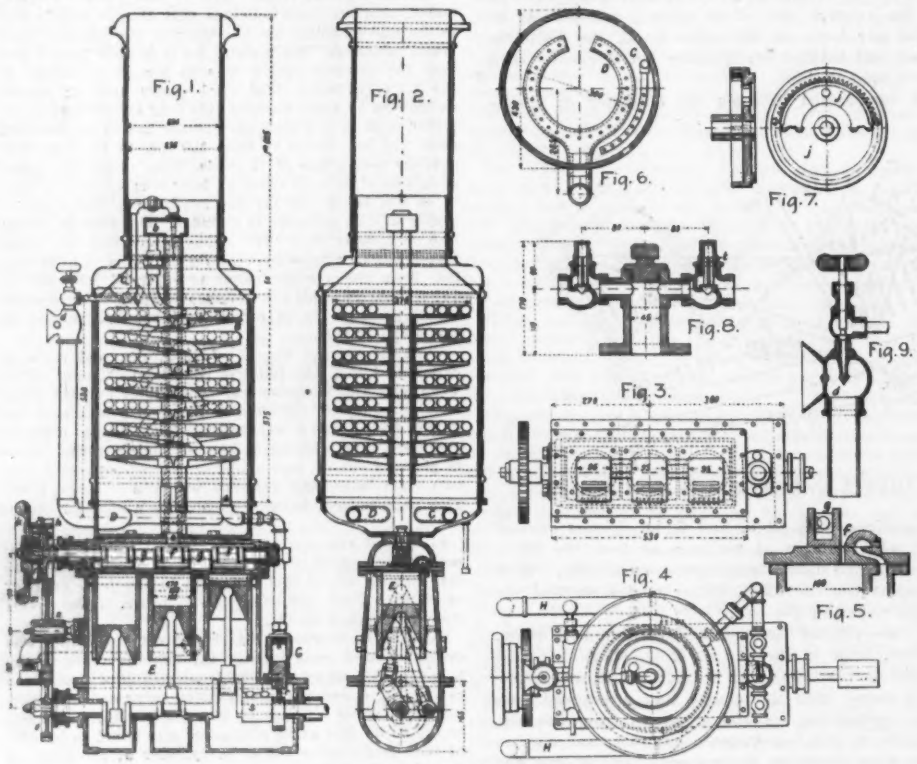
General Results of Locomotive Tests in Heavy Express Service, C., B. & Q. R. R.

Engine and class.	No.	Heating surface, sq. ft. Tubes.	Firebox.	Total.	Grate surface, sq. ft.	Mean running weight.	Weight on drivers.	Dia. drivers, over all.	Exhaust nozzles.	Cylinders, inches.	Engine performance. Consumption per dyna. HP. per hour, cars only. Coal. Lbs.	%	Water. Lbs.	%	Consumption per dyna. HP. per hour, cars and engine. Coal. Lbs.	%	Water. Lbs.	%	Boiler performance. Evaporation from and at 212° F. Lbs.	%	Combus. per sq. ft. grate lbs. per hour. Lbs.	%	Lbs. per ton mile of cars. Coal. Lbs.	%	Water. Lbs.	%
C., B. & Q., Mogul...	145	1,380	126	1,506	27.1	164,500	91,500	68	5	19 × 24	5.76	100.0	32.9	100.0	4.63	100.0	26.5	102.3	6.03	100.0	89.9	100.0	.178	100.0	1.02	100.0
" 8-wheel...	617	1,491	111	1,412	24.5	151,500	95,000	63¾	4¾	18 × 24	5.89	102.0	32.2	100.0	4.76	102.8	25 9	100.0	6.39	95.0	103.9	116.0	.198	111.0	1.07	105.0
" Mogul....	15)	1,380	126	1,506	27.1	164,500	94,500	62	5	19 × 24	6.50	113.0	35.15	109.0	5.21	114 6	28.9	111.6	6.06	95 0	106.0	118.0	.194	109.0	1.06	104.0
" Mog. cmp.	324	1,380	126	1,506	27.1	172,990	98,000	62	5	8 2 × 24	7.67	133.0	42.8	133.0	6.10	131.8	34.0	131.2	6.85	90 0	105.5	117.0	.211	118.0	1.17	115.0
B'ldw. Mg. 4-cyl. "	82	1,906	169	2,135	28.3	197,100	103,000	72	5¼	4 1 × 24	7.94	138.0	39 2	122.0	6.33	136.7	31.2	120.4	6.23	90.0	121.9	136.0	.223	125.0	1.10	108.0

ALUMINUM NAPHTHA YACHT.

The first steam launch built of aluminum was noted in our issue of Nov. 14, 1891, and the first naphtha launch of aluminum was an exhibit at the Frankfort Electrical Exhibition (Eng. News, Oct. 10, 1891). Both of these little craft were built by Escher, Wyss & Co., of Zurich, Switzerland. The principal dimensions of the latter were as follows: Length between perpendiculars, 18 ft.; beam, 4 ft. 3 ins.; depth, 2 ft. 8 ins. The total weight of the boat and its machinery was 970 lbs. In the accompanying cuts we show the general details of the engine and boiler for an aluminum naphtha launch of much larger dimensions recently completed by the same firm, and we are indebted to "Engineering" for these illustrations and the accompanying details of the construction of the craft and its machinery.

The vessel, which is named the "Mignon," is constructed entirely of aluminum, with the exception of portions of the boiler and machinery, the trimmings, and the running rigging. Her total weight is 1½ tons, and her principal dimensions are: Length between perpendiculars, 43 ft.; beam, molded, 6 ft.; depth, molded, 2 ft. 11 ins., and draft 2 ft. 2 ins. The framing is very light. The keel, stem and stern posts are of forged aluminum,



NAPHTHA ENGINE FOR YACHT.

7 ins. × 1 in. The frames are spaced 16 ins. apart, and are 1 × 1 × 1-16 in., except in the engine room, where they are 1½ × 1½ × ¼ in. The shell plating ranges from 3-32 in. to 4-32 in. in thickness, and is riveted with aluminum rivets. The launch is fully equipped, having a balanced rudder and quadrant of aluminum, aluminum awning stanchions and flag poles, and a standing rigging of aluminum wire set up with screws of the same material. In fact, everything about the vessel which could be made of aluminum is of that material. No paint is used, the metal being allowed to retain its natural silver color.

The principal point of interest, however, is the naphtha boiler and motor. The whole of the machinery is of aluminum, including the propeller, with the exception of the cranks and shafting. The boiler is constructed of spiral copper pipes, and is supplied with naphtha from a copper tank, situated at the fore end of the vessel, by means of pipes running inside of the vessel's keel.

Details of the engine and boiler are shown in Figs. 1 to 9. As will be seen from the engravings, the engine is of the three-cylinder, single acting type, and is completely shut in by a close casing. The valve chest is directly above the cylinders, and the three valves are operated by a single shaft, driven by gearing from the screw shaft. A hand-wheel on the valve shaft is arranged in such a way that, by turning it one way or the other, the relative position of the valve shaft is altered as regards the screw shaft, and in this way the reversing of the engine is effected. The boiler is placed over the steam chest of the engine, and consists essentially of a spiral of stout copper tubing tested to a pressure of 245 lbs. per sq. in. This spiral is inclosed in a metal chamber, at the bottom of which are two burners: (1) a large burner D (Figs. 2 and 6) for vaporizing the naphtha in the spiral tube; (2) a small burner, C, for lighting up. When running, the naphtha is drawn by the feed pump, G (Figs. 1 and 8), from the bottom of the reservoir placed in a compartment on the bow of the boat. Two openings are left in this compartment, through which the water streams as the vessel moves, and the reservoir is thus kept cool. From the feed pump the naphtha passes into one end of the copper coil, where it is converted into vapor. On passing out of the end of the coil, the major portion of the vapor passes downward through a large central pipe to the valve chest of the engine, but another portion of it passes by a by-pass, c'', to an air injector, d (Figs. 2 and 11), where it sucks in a current of air through a suitable valve, mixes with it, and passes on to the large burner, D. The vapor, which passes through the engine, passes back to the reservoir in the bow through the two outboard condensers.

To start the engine, air is first pumped into the naphtha reservoir by a hand-pump provided for this purpose. When a suitable pressure is obtained here, a valve leading to the small burner, C, is opened and the vapor, when it issues there, is lighted. When this has been done naphtha is pumped into the copper spiral, where it is heated by the small burner and vaporized. After the pressure has risen to the proper amount, the valve leading to the injector is opened, admitting thus mixed vapor and air to the larger burner, D, and when this is fairly going the launch is ready to start.

The several figures show clearly the construction of the boiler and machinery, and need no further description. The engine is 6 HP., and on the trial trip a speed of a little over 13 kilos per hour was obtained on a consumption of 17½ lbs. of naphtha per hour.

The Daimler petroleum motor for yachts, made by the Daimler Motor Co., of Long Island City and New York, was illustrated and described in our issue of Nov. 24, 1892.

THE LEASE OR TRIBUTE SYSTEM OF MINING AS PRACTICED IN COLORADO.*

The lease system is the gradual result of the development of our larger producing mines throughout the state of Colorado. The operation of a mine, or group of mines by corporations has been attended, in many cases, by disaster, owing to the difficulty of securing a day's work from the men employed in the mine, the loss entailed by careless mining and sorting of high grade ores, and by lax or inefficient management on the part of superintendents and foremen.

Given, therefore, a mine that has been practically abandoned by its owners for the reasons given, but still possessing merit, the lessee appears on the ground and secures a lease for a year, or term of years, from the owner or owners, paying them a royalty upon the gross smelter or mill returns of the ore which he mines. In this way many of our abandoned mines have been reopened by the miner, who with two or more of his associates has been enabled by careful attention to obtain profitable results.

This procedure led to the leasing of portions of a mine to different lessees, the mine still remaining under the control of the owner or owners. The lease-system is now largely in force in Clear Creek and Lake counties, and in order that its workings may be clearly understood we will cite the instance of a well known mine in Georgetown, Clear Creek County. This property is owned and operated by Mr. G. under the lease system, and his methods have proved so successful that his example may be followed with profit by many other mines of this description.

The lessee applies for a lease, we will say, upon a block of ground in level "C." This block of ground is the extension of drift "C" for 100 ft., which he drives at his own expense, the owner furnishing the necessary supplies, powder, fuse and candles, the lessee paying for these and for hoisting the ore and dirt, and all other necessary expenses incident to the handling of the ore. The terms of the lessee are that he should drive a level 100 ft., and have the privilege of back-stoping this ground to the level above. The royalty which he pays to the owner of the property depends upon what the ground immediately behind, above and below him has yielded, if it has been opened, and varies from 25% to 33⅓%. Should the level have been contracted for and driven by the owner, and this 100 ft. of back show ore in paying quantities, the lessee pays a royalty of from 33⅓% to 75% of the gross smelter returns.

By this method the owner develops his mine at little or no cost to himself, the lessee driving levels, sinking winzes, etc., in order that he may open stoping ground. It is evident that under this method the owner takes little or no risk, and is assured of profit if ore is found. The lessees are under full control of the foreman of the mine, and are subject to the same rules as would govern them if under day's pay.

By dividing a mine up into blocks of ground, varying from 50 ft. to 100 ft. in length by the distance between the levels, each lessee works his own particular block of ground, the ore being kept separate, and when delivered on the dump becomes the property of the lessor or owner of the mine. The ore is then shipped to the nearest sampling works and its value ascertained, the lessee paying the cost of the control sample.

The advantages of this system as applied to the mines of Clear Creek County, over the day's pay plan, may be briefly summarized as follows:

1. The mine once opened can be operated with a small working capital.

2. The percentage of profits received from the sale of ore are absolutely net, the lessee paying all costs of mining, hauling, etc.

3. As a lessee is interested directly in the ore which he mines, he will take care that none is lost, either in the mine or in sorting it. As the ore of this district will average at least $200 a ton, and many rich specimens are found, it also precludes the danger to all mine owners of the small peculations by employees.

4. Under the lease system the mine is not liable for lien.

5. The lessee is responsible to the owner of the mine for carelessness of any kind which may result in damage to the mine or accident to men working therein. Under day's pay the owner is responsible to his employees.

6. But little supervision of the men is necessary under ground. They will all do a day's work under the lease system, as they are working for themselves, and a man will work harder for himself than for any one else. The opportunities in a mine for shirking work are perfectly understood by both employer and employees.

7. Economy in the use of supplies of all kinds. Under day's pay a miner will use almost twice as much powder as under the lease system.

8. Miners will take great chances to find pay-ore.

* Abstract of a paper by Benjamin B. Lawrence, Denver Colo., presented at the Montreal meeting of the American Institute of Mining Engineers, in February, as noted in our issue of March 2.

Development will therefore cost little, as every miner working in a mine is interested in its product and the opening of new ground; he is familiar with the mine, and the owner has the benefit of his experience in finding ore, which may often baffle the keenest manager and foreman.

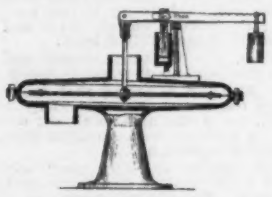
The system has proved an undoubted success in the leading mines of Clear Creek County, and is now being rapidly introduced into the other camps of the state, notably in Leadville and Aspen, as its working is capable of being so adjusted as to suit the charcter of the mine.

It is often necessary, should the mine be in poor ground, to encourage the lessee by what is known as allowance of footage, which means an allowance of, we will say, $2 a foot to drive a drift, which under day's pay or contract, would cost $7 a foot, giving him the privilege of leasing the ground which he opens up. With ample working capital, given a non-productive mine which it is proposed to develop, it is advisable to open the property under contract, leasing the stoping only. The royalties, as has been stated, which rule in Clear Creek County vary from 25% to 75% of the gross mill returns.

It is the popular belief that only those mines which have failed under corporate management are worked under this system, and also that in leasing a mine you are practically "gouging" or destroying it as a workable property. This belief is entirely erroneous, as this system is now applied to some of our best producing mines, and they can be kept in as good condition under the lease system as under day's pay or other plan. The men leasing blocks of ground in this way do not obtain any more privileges than if they were employed by day's pay. The system is recommended to the careful attention of all mine operators.

A NOVELTY IN DRAFT REGULATORS.

The ordinary styles of damper regulator are operated by steam pressure from the boiler, and are designed to regulate the fire in accordance with the demand for steam. The regulator illustrated herewith is for a different purpose. It is designed to prevent the inrush of cold air to the furnace when the doors are opened for firing, or when, through neglect, the fire on the grate gets too thin in places. Its method of operation will be understood by reference to the accompanying cut. In a metal case is mounted a flexible diaphragm of considerable size. Its upper side is open to the air, but its lower side forms, with the case, a closed chamber which is in communication with the combustion chamber of the furnace by means of a pipe. To the center of the diaphragm is attached a rod leading to the lever of a balanced damper in the up-



The Thiell Draft Regulator.

take from the boiler. When the fire is in proper condition the vacuum in the furnace causes an excess of pressure on the upper side of the diaphragm. It is depressed, and in this position holds the damper open. In case the fire on the grate is too thin, or the furnace door is opened, the pressure on the two sides of the diaphragm is equalized and it moves upward, closing the damper and checking the rush of air into the furnace.

It will be apparent that this method of regulation opens the damper wider as the draft increases, hence a second regulator controlling the damper in accordance with the variations in steam pressure is almost a necessity. To meet this requirement, the inventor of the device above illustrated combines with it a regulator, which moves the damper in accordance with the variations in steam pressure.

The device has been recently patented, and is manufactured by the Thiell Combustion Governor & Manufacturing Co., of Baltimore, Md.

THE COMPUTATION OF WATER POWER DAMAGES FOR THE CITY OF CAMBRIDGE, MASS.

One of the most uncertain items in estimates for water supplies to be drawn from sources utilized for water power is the cost of compensating owners of water power.

Mr. L. M. Hastings, City Engineer of Cambridge, Mass., read a paper before the New England Water-Works Association, March 8, in which he described the method employed by him in determining the damages to water power owners on the Charles River, caused by taking water for city uses from a tributary known as Stony Brook. The chief point brought out in the paper, abstracted below, is that in estimating water power damages account must be taken of the freshet flow of the stream, or that part of the flow which must in any case go to waste.

The additional supply from the Stony Brook reservoir was first used in 1887. After the city had settled for loss of power on the brook, the owners of four water powers on the Charles River, below the brook, brought suit against the city of Cambridge for damages caused by loss of power.

The awarding of damages was placed in the hands of a commission. Mr. Hastings presented estimates showing the net available horse power at one of the dams to be 503.27, or 462.20 HP. in case the total flow of Stony Brook was diverted from Charles River, giving an estimated loss of 41.07 HP. at this dam. But these figures of loss did not take into account the fact that during much of the year water is actually wasted, and would be even if the total flow of Stony Brook was used by Cambridge, which is not the case.

Fortunately for the city, one of the companies (the Boston Manufacturing Co., of Waltham) suing for damages had for several years kept records of the depth of the flow of water over the dam. These records the company, with highly creditable kindness, loaned to Mr. Hastings, and from them the conclusion was drawn that during the entire months of January to May, inclusive, and also in December, more water was wasted than the entire flow of Stony Brook. During the months of June and November it was allowed that one-half of the flow of Stony Brook would be lost, and the entire flow during July, August, September and October. The final conclusion reached by Mr. Hastings was that only 15.43 HP. was being lost at the upper dam, on which basis the total loss of power at the four dams was calculated as 34.33 HP., instead of 200 HP. as claimed. The total award made by the commission was $15,000, in place of $160,000. This award was accepted by all concerned. Mr. N. Henry Crafts, C. E., and Mr. Richard A. Hale were associated with Mr. Hastings, and reached substantially the same conclusions by somewhat different methods.

The Philadelphia Public Building Commission is to be abolished by act of the Pennsylvania Legislature, after many years of absolute rule, untrammeled by the wishes of the city councils, which were compelled by law to provide funds for this purpose regardless of other municipal needs. The charges were made that the Commission was wasteful in its methods and unreasonable in its demands. The sum of $17,000,000 has already been expended by the Commission, and after about 18 years work the building is yet far from complete.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

PITTSBURG, McKEESPORT & YOUGHIOGHENY.—The surveys have been practically completed for a line from Scottdale to Latrobe, Pa., to open up the rich coal lands along the route.

OHIO & MISSISSIPPI.—It is announced that this company has secured the right of way for an extension into Bedford, Ind., and that the contract has been let to Marshall, Meyer & Co., of Louisville, Ky.

PERRY COUNTY.—This company has under consideration the construction of a branch from Landesburg, Pa., to Warm Springs, Pa., about three or four miles long.

FINDLAY, FT. WAYNE & WESTERN.—This road has now been completed to the Indiana state line, west of Findlay, O., 11.5 miles of track having been laid this year. Work will be begun soon on the extension to Ft. Wayne, Ind., 19 miles.

WEST PENNSYLVANIA.—Surveys are being made for an extension from near Allegheny Valley Junc. along the north side of the Allegheny River to Clinton, Pa., six miles.

OTTAWA, ARNPRIOR & PARRY SOUND.—This road was completed to Arnprior, Ont., 35 miles west of Ottawa, Ont., on March 1. Work has been commenced on a large bridge over the Madawaska River at Arnprior, and during the coming season the company intends to build the line through Renfrew and Egansville to Barry's Bay, 70 miles west of Arnprior. J. R. Booth, of Ottawa, Ont., Pres.; Geo. A. Mountain, Ottawa, Ont., Ch. Engr.

GEORGE'S VALLEY.—It is stated that work has been resumed on this railway from Union to West Warren, Me., 8 miles. Ch. Engr., Wm. Lee, Bucksport, Me.

Projects and Surveys.

PHILADELPHIA, HONESDALE & ALBANY.—Ch. Engr. F. F. Whittekin has made a preliminary report upon this proposed railway. According to the report the road begins at White Haven, Pa., on the lines of the Central R. R. of New Jersey and the Lehigh Valley R. R., and runs in a northeasterly direction via Gouldsboro, Lake Ariel, South Canaan, Waymart, Prompton and Seelyville to Honesdale. From Honesdale the route goes up the Dyberry to its headwaters, and crosses the divide to the headwaters of the Equinunk Creek, which it follows to Equinunk village. It then goes up the Pennsylvania side of the Delaware until opposite Hancock, where it crosses the river, and from Hancock through the towns and villages of East Branch, Downsville, Shavertown, Arena, Margaretville, Arkville, Roxbury, "Grand Gorge," Moresville, Gilboa, Blenheim, North Blenheim, Breakabeen, Middleburg, Schoharie, Central Bridge, Esperance and Amsterdam to Rotterdam Junction, to a connection with the Fitchburg R. R., and thence over its lines and connections access is had to Boston and all other New England points. The road can be built from White Haven, Pa., to Rotterdam Junction, N. Y., with maximum grades not more than 39.6 ft. per mile against northward bound traffic, and 52.8 ft. per mile against southward bound traffic.

Southern.—Existing Roads.

MACON, DUBLIN & SAVANNAH.—Gen. Man. Jas. T. Wright, Macon, Ga., writes us that the surveys have been completed for the extension from Dublin to Savannah, Ga., 113 miles.

PENNSYLVANIA.—A dispatch from Parkersburg, W. Va., says: "A deal has been closed between the West Virginia & Pennsylvania and the Pennsylvania R. R., by which the latter will obtain the charter, rights of way and general franchises of the former, and proceed at once to build a connection by way of the west side of the Monongahela River to the interior of the state, competing with the Baltimore & Ohio. Although the matter has been canvassed for years, and the necessary preliminaries have been in process of perfection since the spring of 1891, it is only within the past ten days that the programme, as officially arranged, has been given outside headquarters. The line will run direct from Pittsburg to Morgantown, thence to Fairmont, and from there up the line of the Monongahela to Clarksburg, where it will connect with the Camden system for access to the lumber districts. For 40 years past the B. & O. has had a monopoly of the traffic in this state, and every attempt to build competing lines has ended in failure. The fact that they have at last secured a short line to Pittsburg put the Pennsylvania people on their mettle, and they had to either close the deal at once or acknowledge a defeat. An engineer of the company said that all that money can do to push the construction of the line to completion on the shortest possible record will be done between now and the spring of '93, intimating that celerity in building is for some reason, an urgent consideration in the case."

MORRISTOWN & CUMBERLAND GAP.—Surveys are reported in progress for an extension from Morristown to Embreeville, Tenn.

EAST CAROLINA LAND & RY. CO.—Rapid progress is being made on the extension from Jacksonville to New Berne, N. C., 37.4 miles. The grading is now completed to within three miles of New Berne, and 11¼ miles of track have been laid to Starkey's, northeast of Jacksonville, N. C. It is expected to have the line completed by May. Ch. Engr., Foster B. Morse, Wilmington, N. C.

Northwest.—Existing Roads.

GREAT NORTHERN.—Pres. J. J. Hill is reported as saying that one of the two lines projected eastward from the Red River Valley will be extended to Duluth this season.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—A press dispatch dated March 9, says: "A deal was completed to-day for the immediate construction of the western connecting link between the 'Soo' and the Canadian Pacific. The 'Soo' is now in operation to a small town 15 miles north of Barrington, N. Dak. To-day's contract calls for the construction of the remaining 167 miles to the Canadian boundary in the County of Renville, N. Dak., at the point at which the Mouse River enters the United States. One thousand men will leave St. Paul at once to engage in the construction of the line, which must be ready for operation by the first of August. When completed, a number of the Canadian Pacific through trains will make a detour southeastward to St. Paul, taking the main line again at Sault Ste. Marie."

CENTRALIA & CHESTER.—Tracklaying has been resumed on the extension of this road from Hoyleton to Centralia, Ill., 11 miles.

Projects and Surveys.

RICE LAKE, DALLAS & MENOMINEE.—Pres. S. C. Olmstead, 97 Globe, Bldg., St. Paul, Minn., writes us that this railway is projected to run from Rice Lake via Dallas, to Menominee, Wis., 40 miles, and that the surveys are nearly completed from Rice Lake to Dallas, Wis. The route is through a farming and timber country, and the principal business will be in the products of the country. The contract for building seven miles of the line will be let in April. Ch. Engr., H. C. Clark.

CLAYTON & PEA RIDGE.—Surveys have just begun for this railway from Clayton, Ill., northwest to near Huntsville, Ill., 11 miles. Secy., Geo. Wever, Clayton, Ill.

OHIO RIVER & ST. LOUIS.—Chartered in Illinois to build a railway from a point on the Ohio River at Golconda, west through Pope and Johnson counties to a point on the Paducah Division of the Cairo Short Line, at or near the station of Reevesville. The principal office is in Golconda, and the capital stock is $150,000. The incorporators are: James A. Rose, Wm. P. Sloan, Thomas McGown, Harrington Clannohan, Penn V. Trevillion and John Gilbert, Jr., of Golconda; James R. Stegall, of Brownfield, and James A. Whiteside, of Allen Springs.

ILLINOIS.—It is proposed to construct a railroad from Chicago, in a southwesterly and westerly direction through the counties of Cook, Dunage, Will, Kendall, La Salle, Bureau, Putnam, Stark, Henry, Knox, Mercer, Warren, Henderson and Rock Island, to the Mississippi River. The principal office is in Chicago, and the capital stock is $5,000,000. The incorporators and Directors are J. W. Taylor, L. M. Martin, Newton P. R. Hatch, John Davis and David Williams, all of Chicago.

PORTAGE & LAKE DAUPHIN.—The amendments committee of the Manitoba legislature has passed the bill authorizing the construction of this railway. It is projected to run from Portage la Prairie northwest to a point west of Lake Dauphin, 100 miles. The rolling stock, buildings and railway land grant will be exempt from all taxation except those for schools. The land grant will amount to 800,000 acres.

Southwest.—Existing Roads.

TEXAS CENTRAL.—This company has surveyed a line from Dublin to Thurber, Tex., 40 miles, and will probably put it under contract or construction this year.

EXCELSIOR SPRINGS.—Ch. Engr. F. S. Mitchell, Excelsior Springs, Mo., writes us that the present intention of this company is to build a railway from Excelsior Springs, Mo., south to a connection with the Wabash Ry., but that the line will be surveyed to St. Joseph, Mo., with the intention of ultimately extending the line to that place. About ten miles have now been located, and 1½ miles of track laid. Tracklaying will be resumed about April 15, and the line completed by May 1. There is very little heavy work; maximum grade 1% and maximum curve 6°. There will be one 100-ft. span iron bridge and one 80-ft. span combination bridge on the line. S. F. Scott, Kansas City, Mo., Pres.

CHICAGO, ROCK ISLAND & PACIFIC.—All the lumber to be used in constructing bridges for the first 100 miles south from Bowie, Tex., will be furnished by the Reliance Lumber Company, of Beaumont, which has closed a contract with the road for 3,000,000 ft., B. M.

Rocky Mountain and Pacific.—Existing Roads.

GREAT SALT LAKE & HOT SPRINGS.—The preliminary survey is nearly completed for the line from Bountiful to Coalville, Utah, 52 miles. There will be considerable heavy work on the line, including probably two tunnels.

NEVADA SOUTHERN.—Construction on this line from Blake, Cal., on the Atlantic & Pacific R. R., northeast through the New York and Vanderbilt mining districts to Good Springs, Nev., 100 miles, is making rapid progress. About 23 miles of the grading have been completed, and ten miles of track laid. Maximum grade 118.8 ft. per mile; maximum curve 6°. Contrs., Bright & Crandall, San Bernardino, Cal. Ch. Engr., R. B. Burns, Williams, Ariz.

PECOS VALLEY.—As noted last week, this company has completed arrangements for the early construction of an extension. A press dispatch from Santa Fe, N. Mex., says: "J. J. Hagerman and Chas. B. Eddy, of Colorado, the chief promotors of the Pecos Valley irrigation system, have just placed in New York and London $65,000,000 in bonds for the extension of the Pecos Valley R. R. north from Eddy, N. Mex., The new line will run from Eddy to Hagerman, a distance of 60 miles, thence via White Oaks to Bernal Station on the Atchison, Topeka & Santa Fe, 30 miles south of Las Vegas. The latter city will be the terminus of the new line, as the Pecos people have a contract with the Santa Fe to run into Las Vegas over their road. The distance from Eddy to Bernal is 225 miles. Work will begin in two months. The deal involves the building of the Gulf, Colorado & Santa Fe line from San Angelo, Tex., to Pecos City to tap the Pecos line, thus giving the Southern & Gulf section a new route via the Atchison, Topeka & Santa Fe and the Atlantic & Pacific to the coast."

Projects and Surveys.

DENVER & NOLAND.—Chartered in Colorado to build a railway from Denver through Longmont, Indian Mt. and Rabbitt Hill, to Noland, Larrimer Co., Colo. The capital stock is $100,000.

SUN DANCE, SPEARFISH & EASTERN.—Surveys are in progress for this proposed railway from Spearfish, Wyo., to Sun Dance, Wyo.

Foreign.

MEXICO.—A press dispatch from Monterey, Mex., says: "H. A. Smith, a capitalist of this city, who recently built the Porvenier de Matehuala Ry., has obtained a concession from the Federal government for a railway from Vanegas, on the line of the Mexican National Ry., to Parras, on the International line. The projected railway will traverse the rich mineral districts of Mazapil and Concepcion del Oro, and will extend its ramifications to San Carlos on the line of the Mexican International Ry. The terms under which the concession was granted are very liberal, and it is expected that the line will be one of the most important in Northern Mexico."

ELECTRIC RAILWAYS.

CLINTON, MASS.—A franchise has been granted to the Clinton St. Ry. Co. for ten miles of electric railway.

ALBION, N. Y.—There is talk of building an electric railway from Albion to Waterport, N. Y., with branches to Lakeside and Oak Orchard. Frank E. Sickles, Buffalo, N. Y.

HAGERSTOWN, MD.—There is talk of an electric railway. Cy. Engr., J. E. S. Pryor.

COLUMBIA, PA.—Chartered, Columbia Traction Co.; capital stock, $10,000.

POTTSVILLE, PA.—Chartered, Citizens' Electric Ry. Co., of Pottsville; capital stock, $200,000; Pres., L. R. Keefe, Cresson.

READING, PA.—The Reading & Temple Electric Ry. proposes building a branch to Myerstown, 21 miles, work to begin soon.

BELLAIRE, O.—The street railway system of this city will be changed to be operated by electricity. Jolly Bros., Pittsburg, Pa.; A. R. Lydia, Beaver Falls, Pa.

FINDLAY, O.—The Northern Ohio & Lake Erie Electric Ry., Light & Power Co. is to be organized to connect the towns of Findlay, Tiffin, Upper Sandusky and Fostoria with Put-in-Bay and other lake resorts by an electric railway. C. D. Kinney, Cincinnati, O.; R. W. Brown, Tiffin, O.

FREMONT, O.—An application has been made by J. K. Tillatson for authority to build an electric railway; five miles to be finished by June 1.

MASSILLON, O.—There is talk of building an electric railway from this place to Navarre, O., five miles. W. K. L. Warwick and W. B. Hamberger.

NORWALK, O.—The Sandusky, Milan & Hudson Electric Ry. has secured a franchise for an electric railway in this place.

ATLANTA, GA.—The Atlanta Consolidated St. Ry. Co. will apply for a franchise to change a portion of its lines to be operated by electricity.

PARKLAND, KY.—A franchise has been granted for an electric street railway.

BLOOMINGTON, ILL.—The Bloomington & Normal St. Ry. Co. proposes to build electric railways from Bloomington to Leroy and Lexington, about 40 miles.

CHICAGO, ILL.—C. E. Loss, Vice-Pres. Hammond Electric Ry. Co., informs us that work on the line has just been begun; also that he has just let the contract for a $180,000 power-house and car-barn. A 200-HP. Ball engine, duplicate boilers, and two 200-HP. multipolar generators will be installed. C. E. Loss & Co., Pullman Bldg., Chicago, are the contractors for building the whole line. The same firm has the contract for the extension of the Pullman Electric Railway, from 104th St. and Cottage Grove Ave. to Stony Island Ave., for direct World's Fair connection with the World's Columbian Exposition. The improved Patton steam motor will be used on this line. Mr. Wm. Lee is engineer for both these lines.

EDGEWATER, ILL.—The Chicago & North Shore Ry. Co. will build a $30,000 power-house. The work will include the laying of an 18-in. cast iron water main from the power-house to the lake.

JACKSONVILLE.—Chartered, Springfield, Jacksonville & Winchester Electric Ry. Co.; capital stock, $1,000,000; Samuel S. Dewees, Alexander, Ill.

KANSAS CITY, MO.—The Forest Hill Electric Ry. Co. has been organized to build a railway six miles long. C. H. Hammett, L. E. Davidson, Geo. Law, and others are interested.

HORSE AND MOTOR RAILWAYS.

DARTMOUTH, MASS.—A franchise has been granted to the Dartmouth & Westport St. Ry. Co. to build a road from New Bedford to Smith's Mills. Jas. H. McKenzie.

MILLVILLE, N. J.—Chartered, Millville St. Ry. Co.; capital stock, $20,000; W. A. Baland, Lynn, Mass., D. Goff, Millville, N. J.

NEW CASTLE, PA.—Chartered, Brinton Park St. Ry. Co.; Brinton Park to New Castle; capital stock, $20,000; Pres., R. R. McComb.

WILKES-BARRE, PA.—Chartered, Royersford & Spring City St. Ry. Co.; Wilkes-Barre to Spring City; capital stock, $12,000; Pres., G. Mortimer Lewis.

ELEVATED RAILWAYS.

CLEVELAND, O.—It is announced that the financial arrangements have been completed for building the elevated railway from the Public Square to Euclid Heights, and that work preparatory to the construction of the road will begin at once.

BRIDGES, TUNNELS AND CANALS.

VERGENNES, VT.—Bids will be received for the construction of a bridge over Otter Creek. It will have four 125-ft. spans, and carry a 20-ft. roadway and two 6-ft. sidewalks. Estimated cost, $63,000. B. S. Janimas.

BROOKLYN, O.—A bill has been introduced in the state senate authorizing Cuyahoga Co. to appropriate $160,000 for a bridge over Big Creek at this place.

QUINCY, ILL.—The Ohio Southern R. R. will build a bridge 85 ft. high and 1,200 ft. long over the Miami River at this place.

HIGHWAYS.

MASSACHUSETTS.—A syndicate is reported as having assured the construction of a boulevard 125 ft. wide, to connect Newton Centre with Beacon St., Boston.

NEW YORK.—The aqueduct commission, New York, will receive bids until March 29 for constructing highways or roads, and their appurtenances, at reservoir D, in the town of Carmel, Putnam Co.—The legislature has appropriated $10,000 for the protection of highways along the west shore of Owasco Lake.

COLORADO.—A toll road is to be built between Loveland and Estes Park, in Larimer Co. J. R. Stuyvesant, Loveland, is interested.

WATER-WORKS.

New England.

ORONO, ME.—The Public Works Co., of Bangor and Brewer will extend their works to supply Orono, putting in 60 hydrants.

FRANCESTOWN, N. H.—Authority to build works is being sought.

HUDSON, N. H.—The Hudson Water-Works Co. may build works.

MEREDITH, N. H.—Works may be built by the village fire district.

NEW MARKET, N. H.—The people are to vote on building works or granting a franchise for the same; estimated cost, $50,000.

SOUTH NEW MARKET, N. H.—A vote on building works will be taken, but it is reported that it will probably be against the project.

SOUTH ANTRIM, N. H.—The village fire precinct is seeking authority to build works at a cost of not more than $25,000.

BRATTLEBORO, VT.—It is reported that Geo. E. Crowell may add a small pumping plant at West River to his works and a force main about a mile long leading to the Chestnut Hill reservoir.

ANDOVER, MASS.—The people have authorized the water commissioners to issue $10,000 of bonds.

CLINTON, MASS.—The people have accepted the act authorizing an increase in the water supply.

FALMOUTH, MASS.—The Falmouth Heights Water Co. proposes to put in works at once. It is reported that the pump will be driven by a hot air engine and that there will be a tank.

HOLYOKE, MASS.—The contract for 230 tons of 10 to 4-in. pipe has been awarded to the Radford Pipe & Foundry Co., Cincinnati, O., for about $6,000.

PROVINCETOWN, MASS.—Bids for works are wanted, as stated in our advertising columns.

CUMBERLAND, R. I.—The senate has passed a bill authorizing the town to build works with a supply from Sneach Pond, if the people so vote.

PROVIDENCE, R. I.—A committee of three, including City Engr. Herbert M. Shedd, will test different methods of filtration by means of experimental filters placed side by side. It is reported that the principal manufacturers of commercial filters have been invited to submit filters for trial.

WALLINGFORD, CONN.—Five per cent. bonds to the amount of $8,000 are to be issued for the new Muddy River supply.

WATERBURY, CONN.—Cy. Engr. R. A. Cairns estimates that a new supply could be introduced from "The Branch," near Reynolds' Bridge, for $400,000.

Middle.

ALBANY, N. Y.—The council has voted in favor of a supply from Kinderhook Creek and has taken steps to secure the necessary legislation involved.

DUNKIRK, N. Y.—Engr. J. D. Cook, Toledo, will report on the proposed new intake to draw water from the bay.

NEWPORT, N. Y.—Improvements to the works are proposed.

SYRACUSE, N. Y.—The contract for furnishing stop valves for the main conduit line and the Woodland reservoir has been awarded to the Eddy Valve Mfg. Co., Waterford, for $13,150, and for pipe and special castings to R. D. Wood & Co., Philadelphia, for $14,003.

BRADFORD, PA.—Cy. Engr. Dalrymple has made surveys for a pipe line to a proposed 60,000,000-gallon reservoir on Marella Brook, about a half mile above the present reservoir.

BROCKWAYVILLE, PA.—Works are projected, probably by a company.

COCHRANTON, PA.—A citizens' meeting has been appointed to report on securing works.

LEBANON, PA.—The councils have authorized the commissioners to engage an engineer to report on an increased water supply by pumping from Hammer Creek. Chemical analyses will be secured.

ORBISONIA, PA.—It is reported that a company is being formed.

PITTSBURG, PA.—The Monongahela Water Co., which supplies the south part of the city and outlying territory, proposes to extend its works, it is stated, to supply Temperanceville, the boroughs of Elliot, Esplen, McKee's Rocks, the villages of Sheridan, Ingram, Crafton and Idlewild, and the town of Mansfield. It is reported that the principal contracts have been let.

SCRANTON, PA.—W. W. Scranton, Pres. Gas & Water Co., informs us that his company expects to build a dam this summer 50 ft. high, to impound about 1,450,000,000 gallons of water. The dam may be built 60 ft. high, impounding about 2,050,000,000 gallons.

WHITEHALL, PA.—The Whitehall Water Co. has been incorporated; $5,000; Treas., M. E. Kemerer, Manch Chunk.

CUMBERLAND, MD.—The water commissioners have been authorized to expend $3,000 for surveys and estimates for enlarging and improving the water supply.

Southern.

PIEDMONT, W. VA.—It is estimated that works can be built for $43,000.

POCAHONTAS, VA.—The construction of works has just been started. There will be a 1,000,000-gallon reservoir and a supply from the mountains.

SHENANDOAH, VA.—Constr. Engr. H. N. Sims informs us that the Milnes Water Co. has been organized with a capital of $40,000, and will build works estimated to cost $20,000, issuing $15,000 of bonds having interest guaranteed by the town. The supply will be pumped from the river by a 2,000,000-gallon pump. There will be a 250,000-gallon stand-pipe and about five miles of 4 to 8-in. cast iron pipe. The company prefer to let the contract for the whole work to one party. C. J. Stevens, Pres.; C. Powell Noland, Secy. and Treas.; E. Graves, Consult. Engr., Philadelphia.

YORKVILLE, S. C.—The town council has decided that at present the building of works is impracticable.

KEY WEST, FLA.—It is stated that the city commissioners have contracted with the Holly Mfg. Co., Lockport, N. Y., for works at a total cost of $100,000. There will be an artesian well, pumping plant, stand-pipe or pipes and 90 hydrants.

GREENVILLE, MISS.—The city clerk will receive bids until April 4 for building city water-works, under a franchise system. See advertisement.

North Central.

CLEVELAND, O.—Supt. M. W. Kingsley has estimated the cost of the proposed tunnel extension at $800,000.

COLUMBUS, O.—The expenditure of $150,000 for extensions is proposed.

LEAVITTSBURG, O.—It is reported that the Erie Co. is figuring on erecting a stand-pipe 50 ft. high, for a general supply.

NAPOLEON, O.—The council has passed an ordinance providing, it is said, for works.

NORWALK, O.—The water-works trustees report that a 2,500,000-gallon pump, two 5 × 16-ft. boilers and a section of 18 or 20 and 16-in. force main are needed.

SPRINGFIELD, O.—The trustees have recommended the purchase of a 10,000,000-gallon pumping plant, at a new site, which would necessitate a new 24-in. main; estimated cost, $100,000 to $125,000.

WEST MILTON, O.—Gravity works are proposed.

MARTINSVILLE, IND.—Plans for works are being made by Professor Phillips, Lafayette.

TERRE HAUTE, IND.—An addition to the filter plant is talked of.

Northwestern.

SCRANTON, IA.—Works are talked of.

SPENCER, IA.—Steps to secure better works are being taken.

CEDAR RAPIDS, NEB.—Application for a franchise has been made. It is said that the people prefer municipal ownership, and that plans for works have been prepared.

FULLERTON, NEB.—The council has passed an ordinance granting a franchise to Jas. R. Smith.

VENANGO, NEB.—Works are talked of.

Southwestern.

KIRKWOOD, MO.—The Suburban Water Supply Co. has petitioned the county court at Clayton for permission to supply a part of the county adjoining St.

Louis with water. It is proposed to buy the supply from the St. Louis works. W. S. Kuhn, of the American Water-Works & Guarantee Co., Pittsburg, Pa., Chas. Than, Pittsburg, Pa., D. H. McAdam, Kirkwood, and others are interested.

BLOOMING GROOVE, TEX.—It is reported that a contract for works will soon be let.

KARNES CITY, TEX.—The Karnes City Water-Works Co. has been incorporated; $12,000; C. H. Mayfield, Otto Buchel, J. H. Barkley and C. L. Burghard.

STILLWATER, OKLA.—Works have been talked of since a recent fire.

ASPEN, COLO.—Geo. S. Newman & Co. have petitioned for a franchise. A company already supplies the town.

SILVER PLUME, COLO.—It is reported that about three-fourths of the property owners have petitioned the council to issue bonds for works.

Pacific.

KETTLE FALLS, WASH.—Bonds for works may be issued.

TACOMA, WASH.—It is reported that J. Vincent Thompson and C. B. Talbot have offered to introduce 20,000,000 gallons of water daily from the Cascades, for $852,000.

LEBANON, ORE.—It is said that works will soon be built.

MYRTLE POINT, ORE.—H. Orchard, Portland, is trying to secure a franchise.

PORTLAND, ORE.—Contracts for the work recently advertised in this journal have been awarded, as noted under "Contract Prices."

LOS ANGELES, CAL.—The City Water Co. has awarded a contract to J. D. Hooker & Co. to furnish 9,000 ft. of 18-in. pipe to connect the new pumping system with the reservoir system of the Citizens' Water Co. The cost of pipe and laying will be about $20,000.

OCEANSIDE, CAL.—The people have voted $30,000 of bonds to increase the water supply.

SACRAMENTO, CAL.—J. H. Henry has offered to supply water to the city from artesian wells for $40 per million gallons, delivered at the city limits. H. P. Livermore, of the Sacramento County Water Co., has offered to supply water from the South Fork of the American River; price not yet stated.

SAN DIEGO, CAL.—April 11 the people will vote on issuing $650,000 of bonds for the construction or purchase of works.

IRRIGATION.

NEW COMPANIES.—Hampton Land & Canal Co., Uinta Co., Wyo.; $300,000; Emory Andrews, Kennebunk, Me.: H. C. Sherman, Sterling, Colo.; J. C. Hammon, Evanston, Wyo. Chatfield Irrigation Co., Brownsville, Tex.; $1,000,000; Pres., W. H. Chatfield; Engr., J. J. Cocke. Blue Stone Land & Improvement Co., Colorado; $100,000; G. J. Carpenter, Fairbury, Neb.; Chas. N. Cox, Grand Junction, Colo. Palouse Irrigation Co., Washington; $300,000; Frank Shea, Joshua Pierce; to irrigate land west of Calfax.

SEWERS.

SKOWHEGAN, ME.—The citizens have appropriated $20,000 for sewers.

BENNINGTON, VT.—The contract for constructing the proposed sewer system has been awarded to Frank L. Allen, Worcester, Mass.; the contract for pipe to Waldo Bros., Boston, Mass.; and McClintock & Woodfall, Boston, have been engaged to superintend the work.

BEVERLY, MASS.—The citizens have voted to build a brick sewer to cost about $40,000.

BOSTON, MASS.—The metropolitan sewerage commissioners will receive bids until March 25 for section 29 of the main sewer in Cambridge; length, 5,150 ft.; average cut to 8 ins. below inverts, 17 ft.; maximum outside width of masonry, 72 ins.; also for section 45, in Winchester; length, 6,500 ft.; average cut to 8 ins. below inverts, 8.3 ft.; maximum outside width of masonry, 40 ins.

AUBURN, N. Y.—The city clerk has been directed to advertise for bids until April 3 for the Orphan Asylum sewer.

BATAVIA, N. Y.—Plans for a complete system are nearly completed by J. W. Holmes. John W. Law is chairman of the commission.

BROOKLYN, N. Y.—The commissioner of city works will receive bids until March 24 for three sewers.

BUFFALO, N. Y.—The board of public works will receive bids until March 25 for three 10 to 15 in. tile sewers. McGregor & Hughes were the lowest bidders for a brick sewer in Virginia St., at $29,980. The highest bid was $47,000.

COHOES, N. Y.—Plans have been prepared for a 6-ft. sewer 1,600 ft. in length.

ILION, N. Y.—Plans for a complete sewerage system have been prepared and are now on file for public inspection.

ROCHESTER, N. Y.—The East Side trunk sewer commission has awarded the contract for section No. 8 to Wm. Fuller, at $93,533. The total bids were published March 2. The contract for section No. 9 was awarded to Bruff, Horn & Co., at $44,025, the other bids being H. N. Cowles, $52,910; E. C. Louer, $49,683; Robinson & Pond, $62,853; Chambers & Casey, $60,154; Whitmore, Rauber & Vicinus, $64,491; Brayer & Albaugh, $52,936. The entire sewer is now under contract, except the first section, which has been completed. The contract price of the nine sections amounts to about $702.00. The estimated cost of the sewer being $1,000,000, there is left nearly $300,000 for other expenses. Bonds for $500,000 have been issued, realizing a premium of $14,300, and more will be issued soon.——F. P. Stearns, Ch. Engr. Mass. State Bd. of Health, was in the city last week examining the plans of the West Side sewer commission.——The city council has passed ordinances for two sewers to cost about $82,000.

MONTCLAIR, N. J.—The township clerk will receive bids until March 27 for about 50,000 ft. of 8 to 24 in. pipe sewers.

PLAINFIELD, N. J.—The special committee on sewerage has completed its report. Three systems are proposed. One is for a sewer to the Raritan River, seven miles distant, and estimated to cost $184,160, and another for a sewer to Staten Island Sound, 17 miles, to cost $235,474 and $3,000 for annual maintenance. Fanwood, Westfield, Cranford, Roselle and Linden might co-operate in this plan. The intermittent filtration system, as used in South Framingham, Mass., is also proposed, the estimated cost being $87,001.

HARRISBURG, PA.—Important sewerage extensions are being considered.

HOMESTEAD, PA.—Plans are being prepared for 3,500 ft. of 5 and 6 ft. brick sewer; average cut, 12 ft. Elmer Hough, Cy. Engr.

TAMPA, FLA.—We are informed by Wm. C. Brown, C. E., that Geo. E. Waring, Newport, R. I., has been asked to prepare estimates for a sewerage system at this place.

NASHVILLE, TENN.—Authority has been granted to issue the $400,000 of sewer bonds referred to in the information sent us by Jas. A. Jowett, Cy. Engr., and published Jan. 5. These bonds are to be 4½% and will run 30 years. Authority is now sought to reject bids for public work when the bidders propose to employ convict labor.

ALLIANCE, O.—Sewer bonds for $30,000 have been voted.

DAYTON, O.—The city comptroller will receive bids until April 10, for about 6,000 lin. ft. of 4.5-ft. to 6 ft. 8-in. × 8-ft. sewer. See advertisement.

LONDON, O.—J. Arnett, Cy. Engr., informs us that plans have been prepared for a sewer system, but it will not be put in this year.

NORWOOD, O.—The council has voted to advertise for bids for the Elm Ave. sewer.

WELLSVILLE, O.—Plans for a system have been prepared by the city surveyor; length, 8,000 ft.; estimated cost, $40,000.

CARO, MICH.—It is reported that preparations are being made to construct a system of sewerage.

FORT GRATIOT, MICH.—The city council has voted in favor of issuing bonds for $20,000 for sewers.

RED JACKET, MICH.—We are informed by Chas. F. Loweth, Consult. Engr., St. Paul, Minn., that the contract for a sewerage system has been awarded to Wagner, Reid & Sharp, Port Huron, at $29,713. The other total bids were as follows: Dubuque Construction Co., Dubuque, Ia., $26,531; Fred. Youngren, Minneapolis, Minn., $29,876; E. T. Sykes, Minneapolis, Minn., $29,890; August Engman, Minneapolis, Minn., $30,122; A. Anderson, St. Paul, Minn., $30,958; Mair Bros., Port Huron, $31,750; Kirkland & Starkey, St. Paul, Minn., $32,424; Jas. W. Pearl, Benton Harbor, $32,998; John Burns, Minneapolis, Minn., $34,534; G. S. Miller, Council Bluffs, Ia., $35,516; Harman, McDonald & Co., Omaha, Neb., $36,008; T. L. Rosser, Jr., Minneapolis, Minn., $36,308; Jas. Foley, Menominee, $36,688; W. M. Campbell, Menominee, $37,519; P. T. Thornton, St. Paul, Minn., $38,829; John M. Lally, Detroit, $39,280; Whiting & Roehm, Red Jacket, $61,564.

GREENVILLE, ILL.—A special committee has been appointed to confer with a committee appointed by the county board regarding the proposed sewerage system for the city.

SIOUX FALLS, S. DAK.—We are informed by S. B. Howe, Ass't. Engr., that the sewer letting that was to have taken place March 6 has been postponed until March 27. The work includes about ten miles of pipe and three miles of brick or stone sewers, and 12,500 cu. yds. of rock excavation.

JEFFERSON CITY, MO.—The city council has engaged J. B. Gass, Cy. Engr., Fort Smith, Ark., to prepare plans for a complete sewer system.

KANSAS CITY, MO.—Plans have been completed for the Gooseneck Creek sewer; length, 34,536 ft., about one-half being 12-in. pipe; estimated cost, $55,000.

ST. CHARLES, MO.—The council is considering an ordinance granting a franchise to the Lewis-Mercer Construction Co., New York, N. Y.

PALESTINE, TEX.—A sewerage system will be constructed by the Lewis-Mercer Construction Co., New York, N. Y.

BOULDER, COLO.—A special election will be held to vote on the issue of sewer bonds for $33,000.

AUBURN, CAL.—A special election will soon be held to vote on the issue of bonds for $15,000 for a sewerage system.

STREETS.

BROOKLYN, N. Y.—The commissioner of city works will receive bids until March 24 for ten contracts for grading.

NEW YORK, N. Y.—The commissioner of public works will receive bids until March 23 for 5,000 cu. yds. of gravel, 1,000 cu. yds. of trap-rock, and for nine contracts for paving with granite blocks; also until March 29 for six contracts for paving with asphalt.

OLEAN, N. Y.—The awarding of contracts for about 23,000 sq. yds. of brick paving has been postponed until March 27.

HOMESTEAD, PA.—Surveys are being made for about 60,000 sq. yds. of vitrified brick paving, the work to include 20,000 lin. ft. of 6 × 24 ins. sandstone curbing. Elmer Hough, Cy. Engr.

NANTICOKE, PA.—The following estimates have been made by a Wilkes-Barre firm to be considered in connection with the proposed paving of Main St.: Vitrified brick, best quality, laid in tar, $2.07 per sq. yd.; without tar, $1.95; ordinary, laid in tar, $1.95; without tar, $1.80; the brick to be set in each case upon 6 ins. of gravel. If 3 ins. of concrete be substituted for the gravel, the price would be $2.25 instead of $2.07. An 18-in. curb laid on 6 ins. of concrete would cost 85 cts. per lin. ft. The above prices would include a 3-year guaranty, and good vitrified brick properly laid would last 20 years. It is claimed that 24 men, 18 laborers and 6 bricklayers, can pave 500 sq. yds. per day. Belgian blocks on 6 ins. of sand would cost $2, and last 25 years. Asphalt blocks, 10 × 4 × 4 ins., laid on concrete, would cost $2.60.

COATESVILLE, PA.—A special election will be held March 21 to vote on the issue of bonds for $15,000 to continue the improvements that have been in progress for a couple of years.

WILLIAMSPORT, PA.—The council has decided to pave Fourth St. with asphalt.

BALTIMORE, MD.—The mayor has signed ordinances for paving with Belgian blocks, estimated to cost $1,171,000. The work is to be done by the city, the blocks usually costing from $67.50 to $70 per M. Ordinances have also been signed for paving with Trinidad Lake asphalt, the price not to exceed $2.75 per sq. yd.; in Front St., $50,000, and Baltimore St., $100,000.

NORFOLK, VA.—The council has appropriated $22,452 for paving Plume St.

ASHEVILLE, N. C.—Bids will be received at the mayor's office until April 7 and 14, for paving with granite blocks. See advertisement.

JACKSONVILLE, FLA.—The board of public works will receive bids until April 3 for 25,000 sq. yds. of brick paving; bids to be received for brick alone, work alone, and also for both.

KNOXVILLE, TENN.—The board of public works will receive bids until March 20 for 50,000 sq. yds. of brick paving. See advertisement.

LOUISVILLE, KY.—Several contracts have been awarded to J. R. Gleason for paving with Porter repressed brick; also to C. P. Selvage and Levi Tyler for paving with brick made by the Acme Vitrified Brick Co.

CINCINNATI, O.—The board of administration will receive bids until April 4 for paving with brick. The lowest bid for paving Linn St. with brick was that of Chas. N. Danenhower, about $74,000.

NORWOOD, O.—The council has voted to advertise for bids for improving three streets.

HAMMOND, IND.—Street improvement, to cost $100,000, are contemplated.

MILWAUKEE, WIS.—About 20 streets have been selected to be paved with cedar blocks.

MARSHALLTOWN, IA.—The city clerk will receive bids until April 10 for 27,317 sq. yds. of brick paving and 10,640 lin. ft. of stone curbing.

PORTLAND, ORE.—The city has been authorized to issue bonds for proposed paving.

OTTAWA, ONT.—The board of works has voted to pave Rideau St. with asphalt, at a cost of $70,000.

ELECTRICAL.

LEXINGTON, MASS.—F. E. Alderman and A. E. Scott are members of a special committee appointed to investigate the question of street lighting.

FRANKLINVILLE, N. Y.—The village trustees have awarded the contract for an electric light plant to S. A. Spring and W. H. Ferris, representing a local stock company.

WATERTOWN, N. Y.—At an election March 6 the citizens voted in favor of putting in a municipal electric light plant unless the local company or some other company offers to furnish light at $72 per light per year, each light to burn all night and every night.

HAGERSTOWN, MD.—The street commissioners will receive bids until April 3 for 75 to 85 arc lights of 2,000 c. p. for three or five years.

YOUNGSTOWN, O.—The city council desires authority to issue bonds for $175,000 to put in a municipal electric light plant.

DETROIT, MICH.—The legislature has authorized the city to construct a municipal electric light plant to cost $500,000.

ST. CLAIR, MICH.—The electric light commission will receive bids until March 30 for a complete electric light plant for 1,000 incandescent lights, alternating system, and 50 arc lights: also for a vertical tubular boiler and a 150-HP. compound condensing engine.

OSKOSH, WIS.—The contract for city lighting has expired, and the council is considering the advisability of a municipal plant, estimated to cost $50,000.

ALGONA, IA.—We are informed by A. A. Call, mayor, that a plant will be put in soon, and that suggestions or propositions are invited; population, 3,000.

HARRISONVILLE, MO.—The citizens have voted to issue bonds for $12,000 to put in a municipal electric light plant.

SEATTLE, WASH.—It is reported that W. T. Lacy, San Francisco, Cal., and Guy C. Pinney, of this city, are preparing to supply this city with electricity from Snoqualmie Falls, 22 miles distant. A fall of 268 ft. is obtained at the place, and the power is to be conveyed by underground cables. The project, according to press reports, calls for an expenditure of $2,000,000.

NEW COMPANIES.—South Milwaukee Light & Power Co., South Milwaukee, Wis.; $15,000; F. H. Brice, W. W. Williams, A. W. Bell. Bessemer Contract Co., Jersey City, N. J.; $10,000; E. A. Hopkins, Philadelphia, Pa.; J. M. Howard and F. P. Hoffman, New York, N. Y. Eau Claire Telephone & Lighting Co., Eau Claire, Wis.; $5,000; Joseph Culon, Frederick Miner, Marshall Cousins. Hillsboro Electric Light & Power Co., Hillsboro, Ill.; $18,000; Wm. Murdock, H. Humphrey, Wm. H. Howett. Mutual Electric Light & Power Co., Chicago, Ill.; $75,000; Chas. D. Wright, Wm. A. Conover, A. R. Hechman.

CONTRACT PRICES.

BRICK PAVING.—Elkhart, Ind.—A contract for paving with brick has been awarded to A. F. Nims, Omaha, Neb., at $1.37 per sq. yd.; total, about $65,000.

ASPHALT AND BRICK PAVING.—Kansas City, Mo.—Contracts have been awarded for paving with asphalt at $2.50 per sq. yd., and with vitrified brick at $1.39¾ and $1.93.

ASPHALT, BRICK, CEDAR AND GRANITE BLOCK PAVING.—Des Moines, Ia.—We have received from R. B. Dennis, Cy. Clk., a statement of the bids received March 2 for about five miles of paving. The prices are based on a 5-year guarantee, and the contractor is to remove old paving and put in a 6-in. concrete base and top filling of pavement cement containing 10% of Trinidad asphalt: 1, cedar blocks; 2, brick; 3, brick, two courses on sand; 4, granite. The only bid for asphalt was that of E. G. Church & Co., $2.40 or $2.80 per sq. yd. for 5 or 10-year guarantee, respectively.

	1.	2.	3.	4.
M. H. King, Des Moines..	$1.83	$1.80	$1.66	$3.85
E. T. Likes & Co., "	... ...	1.91	...	...
King & Kennedy, "	... ...	2.17	1.84	...
John Lennard, "	... 1.66	1.73	1.68	...
Hurley & Kavanagh, "	... 1.99	2.10	1.95	3.61
Des Moines Brick Mfg. Co.	...	1.73	1.54	...
N. W. Smith, Des Moines.	...	...	...	4.01
W. R. Stewart, Jr., "	...	...	...	3.93
J. B. Smith & Co., Chicago.	2.00	...	...	...

GRANITE CURBING.—Holyoke, Mass.—The contract for 5,000 to 10,000 lin. ft. of granite curbing has been awarded to the W. N. Flyret Co., Monson, at 53.5 cts. per ft., and $1.07 for corners. The highest bids were 58 cts. and $1.16.

BRICK AND CONCRETE WALKS.—Holyoke, Mass.—A contract has been awarded to Geo. W. Richards for laying brick sidewalks, at 43 cts. per sq. yd., and one to J. J. Prew, for concrete sidewalks, at 40 cts. for new work and 30 cts. for covering old walks.

FLAGGING.—Cambridge, Mass.—The contract for 2,500 sq. ft. of North River flagging has been awarded to Austin Ford & Son, at 37.5 cts. per sq. ft., delivered on the street. The price delivered on wharf would have been 35 cts.

DREDGING.—Philadelphia, Pa.—The contract for dredging docks on the Delaware and Schuylkill rivers has been awarded to the American Dredging Co., at 19 cts. per cu. yd., measured in scow.

Wilmington, Del.—Gen. Wm. F. Smith, U. S. Engineer Office, has recommended that the contract for dredging an inland waterway from Ocean City, Md., to Rehoboth, Del., be awarded to B. G. Bailey, Philadelphia, Pa., at 13.5 cts. per cu. yd.

TEAMING.—Boston, Mass.—The water board has awarded the contract for teaming for the year ending March 15, 1894, to Daniel Doherty, at 70 cts. per load for each load within 2.5 miles and $1.20 per load for more than 2.5 miles. The other bids were as follows: G. L. & W. F. Howe, 71 cts. and $1.46; H. P. Nawn, 80 cts. and $1.95; P. F. Lonergan, 59 cts. and $1.34; O. Nute & Son, 59 cts. and $1.75.

LOCK AND DAM.—Charleston, W. Va.—The total bids received for building locks and dams Nos. 10 and 11, of the Great Kanawha River improvement, were as follows: 1, Humphrey Devereux, Shawneetown, Ill., $230,053 for dam No. 10, and $488,725 for dam No. 11; 2, Harold & McDonald, Pittsburg, Pa., $247,416 and $508,-680; 3, Gianini, Foley & Theis, Pittsburg, Pa., $681,370 for No. 11; 4, Zimmerman, Truax & Sheridan, Duluth, Minn., $242,500 and $562,110; 5, Carkin, Stickney & Cram, East Saginaw, Mich., $254,215 and $590,070; Jas. Gianini, Allegheny, Pa., $243,339 for No. 10; Thos. Munford,. Lock No. 7, W. Va., $244,479 for No. 10. The total bids received for dam No. 9 were published in our issue of March 2. The quantities and prices of dam No. 11 are as follows:

		1.	2.	3.	4.	5.
Grubbing and clearing, complete		$100.00	$1,000.00	$1,000.00	$1,000.00	$1,000.00
Crib logs in coffer-dam, 215,000 lin. ft., at		.20	.20	.21	.25	.30
Sheathing, 120,000 ft. B. M., at		30.00	35.00	35.00	30.00	30.00
Coffer-dam filling, 33,000 cu. yds., at		.80	.80	2.00	.80	1.35
Common excavation, 130,000	" "	.60	.70	1.50	1.11	1.00
Hard pan excavation, 5,000	" "	3.00	2.00	2.00	2.00	2.00
Rock excavation, 100	" "	3.00	5.00	3.00	1.00	4.00
Embankment, 14,000	" "	.40	.70	.70	.50	.75
Puddling, 1,600	" "	1.50	3.50	3.00	2.00	3.50
Concrete, 13,000	" "	6.50	7.50	7.50	7.00	7.25
Racking masonry, 5,300	" "	8.00	9.00	9.50	8.00	8.50
Rock face masonry, 3,000	" "	11.50	10.00	11.00	11.00	10.50
Pointed face masonry, 2,450	" "	12.50	12.00	13.50	13.00	13.00
Cut stone masonry, 650	" "	22.00	17.00	18.50	18.00	20.00
Sills, 590	" "	22.00	17.00	18.50	18.00	25.00
Quoins, 80	" "	22.00	22.00	20.50	25.00	25.00
Coping, 970	" "	22.00	18.00	18.50	20.00	20.00
Stone filling, 12,600	" "	1.50	1.40	2.00	1.50	1.50
Rip-rap, hand-placed, 2,800	" "	3.00	2.25	3.50	2.50	3.00
Paving, 1,500	" "	5.00	5.00	5.50	5.00	5.00
Timber in permanent construction, 800,000 ft., B. M., at		45.00	50.00	55.00	45.00	40.00
1,000 permanent piles, per lin. ft.		.30	.40	.90	1.00	.50
4,300 bolt holes in masonry, per lin. ft.		.40	.30	.40	.30	.40

PIPE.—Cincinnati, O.—The following bids have been received for iron pipe for the water-works department: Bradford Pipe Co., Cincinnati, $26.25 per ton for straight pipe, and $70 for special; Dennis Long & Co., Louisville, Ky., $26 and $70; Howard-Harrison Iron Co., St. Louis, Mo., $25.50 and $60; Lake Shore Foundry, Cleveland, $25.80 and $70; Addyston Pipe & Steel Co., Cincinnati, $24.75 and $50. The contract last year was awarded to the Howard-Harrison Co. at $21 and $45.

Austin, Tex.—We have received from W. J. Oliphant, Secy. Bd. Pub. Wks., a statement of the bids received for pipe and castings, to be delivered f. o. b. cars at Austin. The quantities were as follows: 24-in. pipe, 637 tons; 20-in., 340 tons; 16-in., 1,691 tons; 14-in., 382 tons; 12-in., 670 tons; 10-in., 837 tons; 8-in., 458 tons; 6-in., 1,755 tons; special castings, 190 tons. The contract was awarded to the Howard-Harrison Iron Co., Bessemer, Ala., at $25 per ton for the pipe, and $50 for specials; total bid, $178,750. The other bids were the Addyston Pipe & Steel Co., Cincinnati, O., $27.80, $60, $119,606; Dennis Long & Co., Louisville, Ky., $28.49, $60, $204,277; McNeil Pipe & Foundry Co., Burlington, N. J., $25.95, $49, $184,981; Chattanooga Foundry & Pipe Works, Chattanooga, Tenn., $26.50, $50, $188,905; R. D. Wood & Co., Philadelphia, Pa., $26.15, $50, $186,535.

Detroit, Mich.—The contract for iron pipe has been awarded by the water board to the Lake Shore Foundry, Cleveland, O., at $23.75 per ton for all over 4-in., and $24.75 for 4-in.

WATER SUPPLY.—Portland, Ore.—The lowest bids for the Bull Run pipe line water supply system aggregate $1,197,274. The work includes 24 miles of 33 to 42-in. wrought iron conduit and 5.6 miles of 32-in. cast iron conduit. Contracts have been awarded as follows: J. M. Leavens, Portland, construction of head works; clearing and grubbing, 2 acres, $150 per acre; 100 trees cut, $1 each; 8,000 cu. yds. of earth excavation, at 21 cts.; 1,000 cu. yds. of loose rock, and 7,000 cu. yds. of solid rock, at 35 cts.; 100 cu. yds. of rock under water, at $6.

Pacific Bridge Co., Portland, three bridges; 75-ft. span, $1,900; 160-ft. span, $7,700; cylinder piers for same, $700; 300-ft. span, $18,500; cylinder piers, $1,200.

Risdon Iron & Locomotive Works, San Francisco, 11,442,000 lbs. of steel plates for the conduit from the head works to be the Mount Tabor reservoir, at 2.98 cts. per lb.

Hoffman & Bates, Portland, manufacturing and laying the pipe; 11,442,000 lbs. of steel and 340,000 lbs. of rivets, at 2.75 cts. per lb.; 225 manholes, at $20; 34 air valves, at $8; 200 bends, extra joints, at $30; 46 blow-offs, with 6-in. valves, at $20; 29,000 lbs. of 6-in. waste-pipe, at 10 cts.; 580,000 brick, laid in cement, at $21; 2 stand-pipes, 15,000 lbs. of steel plates, at 8 cts.; 33 and 36-in. water valve, $500 each; 30-in., 2, at $350; 40,000 lbs. of 30-in. waste pipe, at 7 cts.; 60 cu yds. of concrete or masonry foundations, at $10; 7,000 lbs. of wrought iron for sleeve joints, at 7 cts.; 3,000 lbs. of lead, at 6 cts.; 40,000 lbs. of wrought iron for trestles, at 6.4 cts.; 400 cu. yds. of concrete foundations, at $8; 270,000 cu. yds. of earth excavation and refill, at 30 cts.; 10,000 cu. yds. of loose rock, at $1.50; 2,000 cu. yds. of solid rock, at $3.

Oregon Iron & Steel Co., Portland, furnishing cast iron pipe, etc., for the main from Mount Tabor to the reservoir in the city park; 6,300 tons of cast iron pipe, delivered in Portland, at $35; laying same in ditch, at $5; 30,000 lbs. of cast iron manholes and 12,000 lbs. of blow-offs, at 5 cts.; 13,000 lbs. of wrought iron waste pipe, at 7 cts.; 10-in. water-valves, 5, at $40; 4-in. air-valves, 10, at $10; 20,000 lbs. of cast iron bends, at 5 cts.; 40,000 cu. yds. of earth excavation and refill, at 36 cts.; 4,000 cu. yds. of loose rock, at 50 cts.; 1,000 cu. yds. of solid rock, $1.50.

No bids were received for lap-welded pipe for the 2,100 ft. of submerged pipe under the Willamette River, and this work will be readvertised.

SEWERS.—Atlantic Highlands, N. J.—We are informed by C. P. Bassett, Ch. Engr., that the contract for a sewerage system has been awarded to Conover & Newton, at $30,677. The other total bids were as follows: Warren & Carroll, $23,214; O'Rielly & Smith, $35,730; F. T. Plunket, $37,947; Hilipot & Ayres, $37,066; Gardner & Barnett, $36, 983; Morgan & Mitchel, $36,884; Thos. T. Regan, $48,804; T. & B. Brady, $67,831; H. P. McTague & Wells, $42,093; McKiernan & Bergan, $41,320; P. H. Harrison, $31,546. The prices of the contract were as follows: 12-in. iron pipe outlet, 1,100 ft., at $2.50; 18-in. vitrified pipe, 340 ft., at $1.50; 15-in., 1,760 ft., $1.20; 12-in., 1,420 ft., $1; 10-in., 730 ft., 90 cts.; 9-in., 500 ft, 90 cts.; 8-in., 31,920 ft., 43 cts.; 18, 15, 12, 10, 9 and 8-in. Y's, $2.50, $2, $2, $1.50, $1.50 and 60 cts.; manholes, 1,000 ft., $3; 30 flush tanks, at $45; lampholes, 75 ft., at $2; concrete, 400 cu. yds., at $1.25; rock excavation, 50 cu. yds., 50 cts.; iron castings, 65,250 lbs., at 3 cts.; iron pipe, 30 tons, at $5; timber, $1 per M. ft.; excavation below grade, 400 cu. yds., at 50 cts.; 4-in. tile, 1,000 ft., at 8 cts.; 6-in., 3,000 ft.. 10 cts.

MISCELLANEOUS.

RAILWAY TIES, ETC.—Montreal, Que.—The harbor commissioners will receive bids until March 21 for 4,000 tamarac and hemlock ties; also for a supply of iron, spikes, bolts, etc.

CEMENT.—Boston, Mass.—The superintendent of streets will receive bids until March 22 for cement in this city, South Boston, East Boston and Charlestown; also in Brighton, West Roxbury, Dorchester and Roxbury.

TIMBER AND LUMBER.—Cleveland, O.—The director of public works will receive bids until March 30 for 900,000 ft. B. M. of timber and lumber for a protection crib for a working shaft to be used while building an extension of the water-works tunnel.

DITCH EXCAVATION.—Danforth, Ill.—The commissioners of drainage district No. 3 will receive bids until March 31, for 250,000 cu. yds. of earth excavation. See advertisement.

CUT-STONE AND BRICKWORK.—Kansas City, Mo.—The contract for the cut-stone and brickwork of basement walls of the proposed public building has been awarded to O. J. King, Omaha, Neb., at $74,557.

PUBLIC BUILDING.—Galesburg, Ill.—The contract for a public building has been awarded to Valentine Jobst, Peoria, at $41,277.

DOCKS.—Buffalo, N. Y.—Bids will soon be asked for important dock extensions.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for 8 mogul freight engines, 2 eight-wheel passenger engines and 2 six-wheel switching engines for the Ohio Southern, and for 40 simple and 10 compound engines for the New York, Lake Erie & Western. The Dickson Mfg. Co., Scranton, Pa., is building 10 consolidation engines for the New York, Ontario & Western. The Schenectady Locomotive Works, Schenectady, N. Y., have built a four-wheel inspection engine for the Adirondack & St. Lawrence. The Lima Locomotive Works, Lima, O., are building 2 Shay geared engines for the Sinnemahoning Valley. The Louisville & Nashville will add 15 locomotives to its equipment.

CARS.—The Jackson & Sharpe Co., Wilmington, Del., and the Gilbert Car Mfg. Co., Troy, N. Y., have each an order for 50 cars for the Lake St. Elevated, Chicago. The Madison Car Co., Madison, Wis., has an order for 500 freight cars for the Denver & Rio Grande and 250 gondola cars for the Pennsylvania. The Louisville & Nashville will add 1,500 freight cars to its equipment. The J. W. Fowler Car Co., Elizabeth, N. J., has been incorporated by J. W. Fowler and John W. Cooper, of Brooklyn, N. Y., and R. C. Swan, of Bayonne, N. J. The Laconia Car Co., Laconia, N. H., had its blacksmith shop, foundry and machine shop destroyed by fire March 9.

BRAKES.—The New York Central & Hudson River has placed an order for 1,200 freight cars, which are to be equipped with the New York Air Brake Co.'s improved automatic freight car brakes.

BRIDGES.—Mr. Lee L. Dagron, of Chicago, has been engaged to inspect the following bridges for the Bangor & Aroostook R. R.: Two 135-ft. spans; three 100-ft., and two 150-ft. through spans, three 100-ft. deck spans, and a large number of plate girders, 30 to 75 ft. long. The work is to be completed by August, and extends over 200 miles of track. Mr. Job. Abbott, of New York, is the consulting engineer. The Wrought Iron Bridge Co., Canton, O., has the contract for the iron work.

BUMPING POSTS.—The Mechanical Mfg. Co., of Chicago, Ill., has an order from the Terminal Railway Association of St. Louis, for 30 Ellis' patent bumping posts, with rubber cushion attachment (Eng. News, Oct. 6, 1892), to be erected in the new passenger station at St. Louis, Mo.

FIREBRICK PLANT.—The plant of the Missouri Clay Co., at Deepwater, Mo., was sold recently by the receiver. This plant cost over $30,000 about two years ago, and was operated but a few months when it went into the hands of a receiver. It will be immediately turned over to the Deepwater Fire Brick & Clay Goods Co., a corporation with $50,000 capital, which will carry on the manufacture of clay goods of various kinds, especially vitrified paving brick and farm tile. Extensive improvements are now under way, and an entire new set of kilns will be built. The newest and most approved appliances are wanted for manufacturing and handling clay goods, and proposals for machinery will be received.

ANCHOR ICE PROTECTORS.—The Washburn & Moen Mfg. Co., Waukegan, Ill., has placed an order with Joseph G. Falcon, Evanston, Ill., for a Falcon rotary strainer to protect its intake water pipe from anchor ice. It is the largest strainer Mr. Falcon has ever made, and will be 16 ft. long, 7 ft. diameter, and will make 15 revolutions per minute in a tank connected to the 36-in. water pipe, 1,728 ft. in Lake Michigan. Washburn & Moen state that the cost this year from being short of water is over $50,000.

W. S. REED & CO., Rookery Building, Chicago, have the contract for building the new water-works and putting in an electric light plant at Mt. Carmel, Ill. They are also to build the Chicago & Southwest Electric Railway, to extend from 95th and State streets to Oaklawn, 7 miles. The new water-works at Covington, Ind., built by Mr. Reed, have been tested and accepted. The company makes a specialty of putting in complete water-works, electric lighting plants and electric railways on the franchise or contract plan.

P. KNUDSON & SON, 874 N. Washtenaw Ave., Chicago, divers and contractors for all kinds of submarine work, have completed a diving boat 30 ft. long 8 ft. beam and 4½ ft. deep. They are prepared to contract for all kinds of work in this line at any point. They have been engaged to lay the Hygeia Mineral Spring Co.'s 7-in. pipe across the Chicago River.

SEELIG & KANDLER, 192 E. Madison St., Chicago, manufacturers of engineering and astronomical instruments, etc. (Mr. Seelig is of the late firm of Heer & Seelig), are about to enlarge their plant, and are now using electric power for their machinery. The firm makes a specialty of surveying and engineering instruments, has an original device for grinding bubbles, and also supplies rods, tapes, and supplies for field and office work. It has recently taken the exclusive agency for the sale in this country of the astronomical instruments of a good European firm, so that orders for these can be filled without extra charge for duty.

THE GATES IRON WORKS, Chicago, Ill., are furnishing a No. 7½ rock crusher (Eng. News, Feb. 9) to the Michigan Stone Co., of Maybee, Mich., together with a 250-HP. Corliss engine, two 300-HP. boilers, burning oil, air compressor plant, etc. They are also furnishing one of their large stone crushers to F. B. Sibley, of Sibley Station, Mich. Secy. and Treas., H. W. Hoyt.

THE LAIDLAW-DUNN-GORDON CO.—An important consolidation of pumping engine manufacturers has been completed at Cincinnati, O. The Laidlaw & Dunn Co., of Cincinnati, and the Gordon Steam Pump Works, of Hamilton, O., are to be united under the above name, with a capitalization of $700,000. A new establishment for the manufacture of pumps and pumping engines of all sizes will be built by the consolidated company somewhere in Cincinnati or its vicinity. The officers of the new company will be as follows: Pres., Robert Laidlaw; Vice-Pres. and Gen. Man., Walter Laidlaw, M .Am. Soc. M. E.; Secy. and Treas., John W. Dunn. Alexander Gordon and Robt. C. McKinney, who have had chief management of the Gordon works, will be on the board of directors of the new corporation.

THE ENTERPRISE MFG. CO., Columbiana, O., reports a very successful year during 1892, both in sawmills and road rollers. It is negotiating for purchase of land with the view of building new and more extensive works.

THE LINK-BELT MACHINERY CO., 39th St. and Stewart Ave., Chicago, is fitting out the lake boats of the Flint & Pere Marquette R. R. with elevators for loading and unloading barrels and sacks. There are two elevators to each boat, having a capacity of 1,000 bbls. per hour. They have also been awarded the contract for equipping the Auditorium annex with a coal handling plant. Among contracts recently completed is the equipping of the warehouses of the Flint & Pere Marquette R. R., at Milwaukee, Wis., with three sets of elevators, each having a capacity of 1,000 bbls. per hour. Pres., E. A. Turner; Cons. Engr., Staunton B. Peck.

NEW COMPANIES.—Urban Construction Co., Jersey City, N. J.; $25,000, all paid in; to build streets and elevated railways; T. B. Atkins, New York, N. Y.; W. H. Taylor, Scranton, Pa., and S. O. Jennings, Brooklyn, N. Y. Waterous Engine Co., St. Paul, Minn.; $200,000; to manufacture water-works supplies and fire apparatus; Chas . H. Waterous, of Brantfort, Ont.; T. J. Waterous and Charles N. Bell. Frost Sewer Pipe Co., Macomb, Ill.; $60,000; Jacob L. Bailey, John Binnie and J. W. McIntosh. Ogden Terra Cotta Co., Newark, N. J.; $100,000, $32,000 paid in; Wm. L. Ogden and H. E. Ogden. International Automatic Air Brake Co., Chicago, Ill; $10,000,000, William N. Harris, John H. Wear and Lewis Berwann. Watson Down Draft Furnace Co., Chicago, Ill.; $10,000,000; E. J. Noble; George F. Westover and M. W. Geisinger. Monmouth Sewer Pipe & Tile Co., Monmouth, Ill.; $50,000; Wm. B. Smith, M. C. Soule and J. H. Pattee. American Street Surveying Co., Chicago, Ill.; $800,-000; Hugh R. Beau, George B. Sinclair and Joseph Wright. Teckner Contracting Co., Chicago, Ill.; $10,-000; Charles M. Teckner, J. H. Brown and D. H. Fisher. Johnson Furnace Co., Chicago, Ill.; garbage furnace; $600,000; E. M. Guenther and Wm. E. Dallas. Minneapolis Paving & Contracting Co., Minneapolis, Minn.; $50,000; J. A. Johnson, Olaf Wald and M. O. Luttgen, Dubuque Construction Co., Dubuque, Ia.; $50,000; Pres., M. Tschirgi, Jr.; Secy., P. S. Webster. Iowa Paving Brick Co., Boone, Ia.; $100,000; Pres., C. F. McCarthy; Secy., T. M. Lee.